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EXPERIMENTS WITH WHEAT, OATS, AND BARLEY IN SOUTH DAKOTA.[1]

By MANLEY CHAMPLIN,
Collaborator and Scientific Assistant, Office of Cereal Investigations, and Assistant Agronomist, South Dakota Agricultural Experiment Station.

IMPORTANCE OF THE CEREALS.

The common grain crops, wheat, oats, and barley, have been one of the chief sources of wealth in South Dakota for a number of years. In 1903, the first year of the period discussed in this bulletin, 3,424,000 acres of wheat were grown in the State, with an average yield of 13.8 bushels to the acre, or a total yield of 47,253,000 bushels. Since that year the acreage has remained about the same, and the yield has approximated 13 bushels to the acre in normal seasons. There have been two poor crop years, 1904, when there was a serious epidemic of rust, and 1911, when drought reduced the crop. The average annual yield of wheat in the State during the 10-year period from 1903 to 1912, inclusive, was 12.01 bushels to the acre.

The area devoted to the oat crop has increased from 706,000 acres in 1903 to 1,540,000 in 1912, or has more than doubled in the 10 years. The total yield likewise has almost doubled, being 52,052,000 bushels in 1912, as compared with 27,267,000 bushels in 1903. The average yield to the acre for the State during the 10-year period has been 26.3 bushels. Barley has also more than doubled in importance. The total yield of this crop has increased from 10,656,000 bushels in 1903 to 23,062,000 bushels in 1912, the average acre yield for the period being 23.8 bushels.

It is apparent from these figures that wheat still ranks first in importance, with oats second and barley third, but that there is an increasing tendency toward greater diversification and the increasing of the acreage of other crops than wheat.

[1] Cooperative experiments with cereals have been conducted by the South Dakota Agricultural Experiment Station and the Office of Cereal Investigations of this bureau for the past 10 years. Sufficient data have been accumulated to warrant the recommendation of certain varieties of wheat, oats, and barley as the most profitable ones to grow in South Dakota and adjacent portions of the near-by States. These data, with descriptions of the recommended varieties, are presented in this bulletin.—WM. A. TAYLOR, *Chief of Bureau.*

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NEED FOR IMPROVEMENT.

While the showing made by the above totals is impressive, it does not imply that there is no further opportunity for improvement. The acre yields have not increased during the period, but have remained about the same, fluctuating according to the quantity and distribution of the rainfall. As there is relatively little new land available that is adapted to the profitable production of these crops, future increase in production must come largely through increased yields per acre. The present average yields, 12 bushels for wheat, 26.3 bushels for oats, and 23.8 bushels for barley, are not enough. Production must be increased to keep pace with the constant increase of population.

Whether or not production is increased will depend partly upon the improvement of economic conditions. There is now far too much land farmed by short-term renters who care little about crop or soil improvement. It rests largely with the landowners whether or not the yields per acre are to be increased.

The requirements for crop improvement are essentially the following:

(1) Better varieties.
(2) Better seed.
(3) Better rotations.
(4) Better soil treatment.
(5) Better tillage and cultivation.
(6) Better economic conditions.

It is the purpose of this paper to discuss the first two essentials, better varieties and better seed, and to present the results of investigations pertaining thereto.

CLIMATIC CONDITIONS.

The data which follow and the rainfall map [1] (fig. 1) will aid in the proper interpretation of the results here reported. It will be noted that one of the stations, Brookings, is located in the subhumid belt where the rainfall averages from 20 to 25 inches, while Eureka, Highmore, and Cottonwood, the other three stations from which results are reported, are all located in the semiarid belt where the average rainfall is from 15 to 20 inches. This quantity of rainfall would be sufficient to produce a cereal crop every year with good farming methods if it was not for the frequently recurring hot winds which blow from the south and southwest during the summer months. At such times evaporation and transpiration are excessive, so that the common cereals are severely damaged and sometimes destroyed.

Under these conditions marked differences appear in the ability of varieties to utilize what little moisture there may be in the soil. A great deal also depends upon the stage of growth of the crop at the time these severe conditions occur, the flowering period being the time when it is most subject to injury. It is for this reason that so much confusion exists regarding the desirability of early or late

[1] The data and map are from U. S. Department of Agriculture, Weather Bureau, Climatological Service, South Dakota section, Annual Summary, 1911. 1912.

maturing varieties as well as early or late seeding. The whole question depends upon the time of occurrence of the hot wind or the high evaporation. Thus, some seasons are favorable to early-maturing and some to late-maturing kinds. A 10-year average shows little difference between the yields of good early and good late varieties. The hot winds have sometimes occurred during the last week in June, injuring early varieties, while in other seasons they have occurred during the last half of July, thus injuring the late varieties. Only once during the 10-year period (in 1911) have they been so serious as to totally destroy the cereal crops at the western substations.

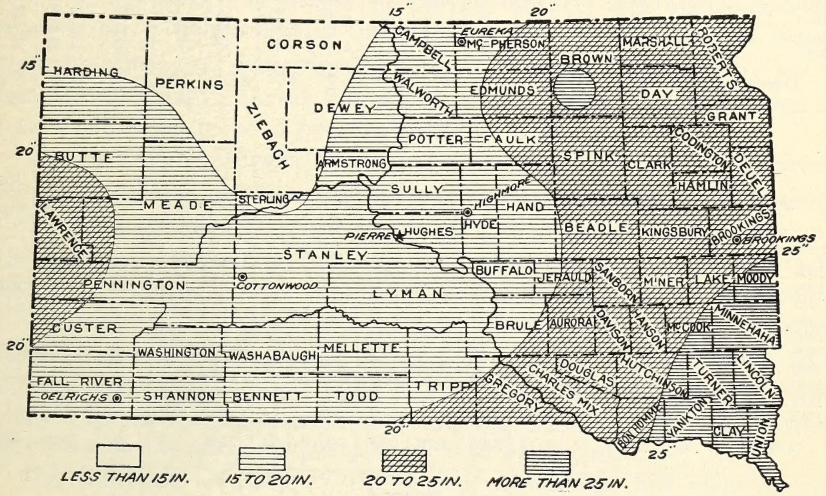


FIG. 1.—Map of South Dakota, showing the average annual precipitation in inches and the location of the agricultural experiment station and substations.

The monthly, seasonal, and annual rainfall by years at the stations at Brookings, Highmore, Eureka, and Cottonwood, S. Dak., are shown in Table I, with averages for the periods for which records are reported and a summary of these averages.

Table I shows that the average seasonal rainfall at Brookings for the five months from April 1 to August 31 is 15.63 inches, or 68 per cent of the annual precipitation. June has been the month of greatest rainfall, with May ranking next in order. There have been two seasons when drought conditions occurred, 1904 and 1910; 1908 was the year of greatest rainfall. In 1903 the cereal crops at Brookings were destroyed by hail, a fact not shown in Table I. In brief, there have been seven good and three poor crop years in the 10-year period from 1903 to 1912.

TABLE I.—*Monthly, seasonal, and annual precipitation in inches in South Dakota at Brookings and Highmore for the 10 years from 1903 to 1912, at Eureka for the 4 years from 1909 to 1912, and at Cottonwood for the 3 years from 1910 to 1912.*

BROOKINGS.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Apr. 1 to Aug. 31.	For the year.
1903	0.10	0.31	1.87	1.00	4.53	4.16	3.30	4.25	2.73	1.85	0.10	0.45	17.24	24.65
1904	.04	.15	.25	1.78	1.82	4.30	1.91	.93	.93	3.15	.02	.20	10.74	15.48
1905	.22	1.00	.68	1.01	6.14	6.09	.98	4.54	2.16	1.50	2.45	[1] T.	18.76	26.77
1906	.17	.02	.58	1.40	3.51	4.89	1.86	4.28	5.13	3.01	.89	.52	15.94	26.26
1907	1.06	.28	.55	1.17	2.36	5.65	3.77	1.41	1.28	.96	.10	1.12	14.36	19.71
1908	.20	1.80	1.16	2.10	6.46	6.35	4.69	2.37	3.89	1.42	1.30	.60	21.97	32.34
1909	1.20	1.57	.37	1.16	4.75	2.29	2.44	3.39	1.67	1.71	.65	1.14	14.03	22.34
1910	1.07	.40	.50	2.34	.87	1.85	1.68	2.46	.96	.38	.17	.10	9.20	12.78
1911	.61	.53	.53	1.62	1.90	3.78	3.32	3.81	3.08	5.12	.23	.42	14.43	24.95
1912	.28	.24	.26	3.36	6.98	2.09	2.52	4.68	1.61	.96	T.	.20	19.63	23.18
Average..	.50	.63	.63	1.69	3.93	4.15	2.65	3.21	2.34	2.01	.59	.47	15.63	22.85

HIGHMORE.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Apr. 1 to Aug. 31.	For the year.
1903	0.05	0.30	0.87	0.70	0.85	2.93	3.58	2.40	1.46	0.66	0.65	0.63	10.46	15.08
1904	.15	.17	.05	1.43	.99	2.25	2.40	1.48	.38	.60	T.	.60	8.55	10.50
1905	.60	T.	.60	1.39	5.23	5.64	5.54	3.56	.56	1.95	1.29	T.	21.36	26.36
1906	.30	.40	.80	2.40	5.00	2.50	1.19	6.25	2.80	.30	2.47	.40	17.44	24.91
1907	1.00	.40	1.10	.68	5.11	1.62	3.64	.18	1.04	1.96	.05	.40	11.23	17.28
1908	.10	.93	.80	1.55	2.68	5.78	2.49	3.53	.62	2.19	1.39	.31	16.03	22.37
1909	.26	.34	.13	.30	4.72	1.69	1.81	3.92	1.70	1.04	.71	1.41	12.44	18.03
1910	.82	.19	.58	1.40	.94	3.74	.85	.66	.89	.24	.40	.44	7.59	11.15
1911	.11	.39	2.54	.32	2.31	.09	2.69	2.52	3.06	1.05	.35	.44	7.93	15.87
1912	.13	.11	.27	1.05	2.20	1.31	1.44	3.39	.71	.20	.00	.35	9.39	11.16
Average..	.35	.32	.77	1.12	3.00	2.76	2.56	2.80	1.32	1.02	.73	.50	12.24	17.27

EUREKA.

1909	0.10	0.45	0.14	0.50	2.65	3.35	2.21	1.39	1.25	0.17	4.50	2.40	10.10	19.11
1910	.60	1.70	1.23	.82	.42	3.80	.53	2.60	3.65	.18	T.	.25	8.17	15.78
1911	.50	.73	.62	2.24	.97	1.29	.43	3.57	1.15	.61	.88	.80	8.50	13.70
1912	.25	.40	1.05	1.29	3.37	1.50	2.19	3.27	1.43	.07	T.	.11	11.62	14.93
Average..	.36	.82	.76	1.21	1.85	2.49	1.34	2.71	1.87	.26	1.35	.89	9.60	15.88

COTTONWOOD.

1910	0.66	0.07	0.76	1.06	2.54	1.30	1.11	0.48	0.82	0.32	0.30	3.00	6.49	12.42
1911	T.	.15	T.	.85	1.10	.64	.59	2.41	3.59	1.15	.20	.42	5.59	11.10
1912	.17	[2]	3.00	3.32	1.19	.92	2.42	3.42	1.30	.11	T.	.12	11.27	15.97
Average..	.28	.08	1.25	1.74	1.61	.95	1.37	2.10	1.90	.53	.17	1.18	7.78	13.16

SUMMARY OF AVERAGES.

Station.	Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Apr. 1 to Aug. 31.	Annual.
Brookings..	1903–1912	0.50	0.63	0.68	1.69	3.93	4.15	2.65	3.21	2.34	2.01	0.59	0.47	15.63	22.85
Highmore..	1903–1912	.35	.32	.77	1.12	3.00	2.76	2.56	2.80	1.32	1.02	.73	.50	12.24	17.27
Eureka.....	1909–1912	.36	.82	.76	1.21	1.85	2.49	1.34	2.71	1.87	.26	1.35	.89	9.60	15.91
Cottonwood	1910–1912	.28	.08	1.25	1.74	1.61	.95	1.37	2.10	1.90	.53	.17	1.18	7.78	13.16

[1] T.=trace.

[2] No record. Precipitation very slight.

At Highmore the average seasonal rainfall from April 1 to August 31 during the 10 years under consideration, as shown in Table I, has been 12.24 inches, or 71 per cent of the total annual rainfall, with the heaviest precipitation in May. There have been four seasons of drought, three of which, 1910, 1911, and 1912, have occurred in sequence, thus rendering dry-farming methods of little avail in the production of cereals during 1911 and 1912. The rainfall has approximated the average during three seasons, while in three seasons it has been much heavier than the average. In brief, there were eight seasons when fair to good crops could be obtained by good farming methods, one season of partial failure, and one season of total failure. Thus, during two of the four dry seasons good crops were obtained and in a third a partial crop was obtained by good farming methods. In all four of the dry seasons the crops were a total failure where poor farming methods were employed.

The record for Eureka covers but four years and is therefore not at all conclusive. It shows that the average seasonal rainfall during this period was 9.6 inches, or 60 per cent of the annual precipitation. During the last three years the same drought conditions as were noted at Highmore have prevailed, though they were not as severe.

The record for three years at Cottonwood shows that the same drought conditions occurred there as prevailed at Highmore and Eureka from 1910 to 1912. The lack of rainfall in June during these seasons has made the raising of wheat, barley, and oats unprofitable. The seasonal rainfall has been 59 per cent of the total.

The summary of Table I shows that Brookings has received an average of 2.75 inches more seasonal rainfall than Highmore. Apparently, Cottonwood and Eureka do not differ essentially from Highmore in the matter of average annual precipitation.

The climatic conditions as a whole are favorable to the production of small cereals as well as other crops at Brookings. At Highmore such cultivated crops as corn, sorghum, and potatoes have not failed during the 10 years. The noncultivated cereals have been a total failure one year and a partial failure another year, even where the best moisture-conservation methods have been employed, that is, where the small grain has followed an intertilled crop. Where small grain has followed small grain there have been four failures—one total and three partial. Thus, there was a net gain of 2 crops in 10 due to good farming, besides the increased yields in normal years.

SOIL CONDITIONS.

The soils of South Dakota east of the Missouri River are nearly all of glacial origin, consisting usually of rich dark-colored loams containing varying proportions of sand, underlain by "bowlder"

clay containing rounded granitic stones commonly known as "hardheads." These glacial soils are well suited to cereal production. The soils west of the Missouri River are alluvial or residual in their origin, that is, they are either the result of deposits of sediment or were formed in place by the disintegration of the underlying rocks. For this reason these soils are extremely variable. Several types of soil may be found on the same farm. The general soil types include a sandy loam in the southern, a sticky clay in the central, and a silt loam in the northern part of this section.

The soil of the Brookings field is a medium sandy loam, that of the Highmore field a medium clay loam, that of the Eureka field a sandy loam, and that of the Cottonwood field a sticky clay, known locally as gumbo.

Thus, the four fields represent, in a general way, the common soil types of the State. However, there are many local variations in the character of the soil which may influence the results when the crops here discussed are grown on other farms.

HISTORY OF THE COOPERATIVE EXPERIMENTS.

The cooperative study of the grain crops in South Dakota was begun in 1903 by the South Dakota Agricultural Experiment Station and the Office of Cereal Investigations of the United States Department of Agriculture. The first purpose of the work was to determine what varieties were best adapted to South Dakota conditions. Several hundred introductions were made from various parts of the world and were placed on trial. Many were found to be entirely unfit the first season, while others were grown for several years before it could be definitely determined whether they were suitable. The varieties discussed in this bulletin are the best of the many which were tested. After having learned something of the relative value of the different varieties, work was begun in 1910 toward the improvement of the best ones.

Portions of the work have been reported from time to time in various bulletins of the South Dakota Agricultural Experiment Station [1] and of the United States Department of Agriculture.[2] The

[1] Shepard, J. H. Macaroni wheat; its milling and chemical characteristics. South Dakota Agricultural Experiment Station, Bulletin 82, 45 p., 6 pl., 1903.

Chilcott, E. C., and Cole, J. S. Cooperative cereal investigations at Highmore. Summary of results for 1903. South Dakota Agricultural Experiment Station, Bulletin 84, p. 9–14, 1904.

Shepard, J. H. Macaroni wheat; its milling and chemical characteristics and its adaptation for making bread and macaroni. South Dakota Agricultural Experiment Station, Bulletin 92, 39 p., 4 pl., 1905.

Cole, J. S., and Balz, Sylvester. Cereal investigations at Highmore. South Dakota Agricultural Experiment Station, Bulletin 96, p. 45–60, fig. 4, 1906.

Shepard, J. H. Macaroni or durum wheats. (A continuation of Bulletin 92.) South Dakota Agricultural Experiment Station, Bulletin 99, p. 105–115, 1906.

period during which the experiments have been conducted is now sufficiently long to warrant the summarizing of the most important results in a single paper.

Some important facts have been brought out. Those varieties which have given the best results almost invariably have come from regions of similar climate. Climatic conditions so far dominate soil conditions that the State may be roughly divided into two sections, one subhumid and the other semiarid. Each section has its specially adapted varieties, though some are adapted to both. The important practical problem now is how to encourage the more common use of these varieties.

EXPERIMENTS WITH WHEAT.

PRODUCTION IN SOUTH DAKOTA.

The production of wheat in South Dakota has remained stationary during the 10-year period under discussion (1903 to 1912). In Table II it is shown that the lowest yield of this period was produced in 1911. During that season the return was only about 50 per cent of the cost of production, while in 1904 it averaged 4 per cent less than the cost of production. During the remaining eight years wheat production has been profitable to the State as a whole. The highest gain, 46 per cent over the cost of production, was obtained in 1909. The average gain for the whole period for the entire State has been 20 per cent on the production cost. In making these estimates the average cost of production for a period of years has been considered as equivalent to the value of a yield of 10 bushels to the acre. That is, it takes approximately the first 10 bushels per acre each year to pay the cost of production, not taking into account the plant food removed. While it is true that such an estimate can not be used in determining the profits of any individual farmer, owing to local and seasonal variations, it serves as a broad economic basis by which the profits of wheat production in general may be measured. On the whole, wheat growing has been profitable during the decade, if the loss in soil fertility is not considered. Up to the present time very little consideration has been given to this factor by the farmers.

Willis, Clifford. Report of progress in variety tests of oats. South Dakota Agricultural Experiment Station, Bulletin 110, p. 421–450, illus., 1908.

Willis, Clifford, and Bopp, J. V. Report of progress in variety tests of barley. South Dakota Agricultural Experiment Station, Bulletin 113, p. 501–522, illus., 1909.

Willis, Clifford. Report of work for 1907 and 1908 at Highmore substation. South Dakota Agricultural Experiment Station, Bulletin 115, p. 557–570, 1909.

Willis, Clifford, and Champlin, Manley. Progress of grain investigations. South Dakota Agricultural Experiment Station, Bulletin 124, p. 19–55, 1910.

Willis, Clifford, and Burleson, W. L. Progress of wheat investigations. South Dakota Agricultural Experiment Station, Bulletin 128, p. 123–144, illus., 1911.

[2] Salmon, Cecil. Dry-land grains for western North and South Dakota. U. S. Department of Agriculture, Bureau of Plant Industry, Circular 59, 24 p., 1 fig., 1910.

TABLE II.—*Acreage, production, and yield per acre of wheat in South Dakota for the 10 years from 1903 to 1912, inclusive.*[1]

Year.	Acreage.	Production.	Yield per acre.	Year.	Acreage.	Production.	Yield per acre.
		Bushels.	*Bushels.*			*Bushels.*	*Bushels.*
1903	3,424,000	47,253,000	13.8	1909	3,217,000	47,060,000	14.6
1904	3,287,000	31,557,000	9.6	1910	3,650,000	46,720,000	12.8
1905	3,221,000	44,133,000	13.7	1911	3,700,000	14,800,000	4.0
1906	3,131,000	41,955,000	13.4	1912	3,700,000	52,185,000	14.2
1907	2,900,000	32,480,000	11.2				
1908	2,958,000	37,862,000	12.8	Average..	3,318,800	39,600,000	12.0

[1] Data supplied by the Bureau of Statistics, U. S. Department of Agriculture.

VARIETAL TESTS.

The acre yields in bushels obtained in varietal tests of wheat at Brookings, Highmore, Eureka, and Cottonwood are shown in Table III. The results for eight years (1905 to 1912) are given for Brookings and Highmore and for four years (1909 to 1912) in the case of Eureka and Cottonwood. These yields were produced without fertilizers and without systematic rotation, the method being strictly comparable to that in use by the majority of farmers. Any gain in yield over the average for the State may be ascribed to the producing power of the variety, to well-cleaned seed, and to good tillage rather than to fertilization or good rotation methods.

TABLE III.—*Annual and average yields in bushels to the acre of wheat varieties grown at Brookings, Highmore, Eureka, and Cottonwood, S. Dak.*

BROOKINGS.

S. Dak. No.[1]	C. I. No.[2]	Variety.	Yield per acre (bushels).								
			1905	1906	1907	1908	1909	1910	1911	1912	Average.
		Bluestems:									
74	.....	Haynes (Minn. No. 51).....	15.7	21.8	9.2	12.1	15.1	13.7	3.8	19.6	13.8
169	2874	Haynes (Minn. No. 169)....	16.3	21.8	8.4	11.6	16.9	15.7	2.8	[3] 19.0	14.0
		Fifes:									
136	3022	Rysting (Minn. No. 171)...	15.8	23.4	7.3	14.9	15.5	16.9	[3] 3.0	[4] 17.4	14.3
142	2989	Power (Minn. No. 66)	16.8	23.1	6.8	10.1	13.3	14.0	1.6	[3] 17.0	12.8
69	1517	Ghirka.....	11.3	19.0	7.8	8.8	17.7	16.2	0.8	18.0	12.4
		Bearded fife:									
67	3081	Red Fife.....	18.3	22.3	10.9	15.0	21.8	19.9	2.8	18.5	16.1
		Durums:									
150	.....	Arnautka.....	25.0	35.8	20.8	25.8	16.5	12.0	4.0	26.1	20.8
73	1516	Kubanka.....	20.8	30.3	6.2	12.8	15.7	5.5	2.8	28.6	15.3
75	1440	Do.....	16.3	28.6	14.5	16.1	11.8	12.7	1.2	28.0	16.2
152	1541	Do.....	16.5	30.4	12.7	15.8	18.0	9.2	3.8	21.6	16.0
		Average of 2 bluestems...	16.0	21.8	8.8	11.8	16.0	14.7	3.3	19.3	13.9
		Average of 3 fifes.....	14.6	21.8	7.3	11.2	15.5	15.7	1.8	17.4	13.2
		1 bearded fife.....	18.3	22.3	10.9	15.0	21.8	19.9	2.8	18.5	16.1
		Average of 4 durums.....	19.6	31.3	13.5	18.6	15.5	9.8	2.9	26.0	17.1

[1] South Dakota number.
[2] Cereal Investigations number.
[3] Yield estimated.
[4] Average of 6 plats.

TABLE III.—*Annual and average yields in bushels to the acre of wheat varieties grown at Brookings, Highmore, Eureka, and Cottonwood, S. Dak.*—Con.

HIGHMORE.

S. Dak. No.	C. I. No.	Variety.	Yield per acre (bushels).								
			1905	1906	1907	1908	1909	1910	1911	1912	Average.
		Bluestems:									
140	.....	Haynes	24.8	16.2	16.7	13.6	16.2	7.7	0	0	11.9
145	.....	Okanogan	23.3	15.0	18.5	16.2	15.8	8.3	0	0	12.1
74	.....	Haynes (Minn. No. 51)	22.8	17.0	16.0	16.3	15.8	9.5	0	0	12.2
169	2874	Haynes (Minn. No. 169)	23.1	17.3	[1] 16.1	14.7	17.2	10.0	0	0	12.3
		Fifes:									
136	3022	Rysting (Minn. No. 171)	15.8	18.2	13.2	11.0	16.8	9.8	0	0	10.6
142	2989	Power (Minn. No. 66)	20.5	14.8	12.5	16.1	16.5	10.3	0	0	11.3
69	1517	Ghirka	9.7	22.0	15.0	4.8	17.7	6.2	0	0	9.4
		Bearded fife:									
67	3081	Red Fife	25.5	20.3	18.7	11.0	17.5	6.8	0	0	12.5
		Durums:									
75	1440	Kubanka	23.2	26.7	28.7	22.7	17.0	8.0	0	0	15.8
73	1516	Do	28.5	31.2	26.8	27.5	14.8	13.0	0	0	17.7
152	1541	Do	26.7	25.5	21.7	22.5	10.7	8.3	0	0	14.4
	1350	Pererodka	28.3	28.5	27.3	22.0	17.2	6.2	0	0	16.2
150	.....	Arnautka	36.7	23.8	23.8	26.0	14.2	5.0	0	0	16.2
72	1513	Beloturka	35.8	22.8	24.2	27.8	12.5	2.0	0	0	15.6
		Average of 4 bluestems	23.5	16.4	16.8	15.2	16.3	8.9	0	0	12.1
		Average of 3 fifes	15.3	18.3	13.6	10.6	17.0	8.8	0	0	10.5
		1 bearded fife	25.5	20.3	18.7	11.0	17.5	6.8	0	0	12.5
		Average of 6 durums	29.9	26.4	25.4	24.8	14.4	7.1	0	0	16.0

EUREKA.

		Bluestem:									
169	2874	Haynes (Minn. No. 169)	.....	.....	.....	.....	10.1	2.3	0	5.2	4.4
		Bearded fife:									
67	3081	Red Fife	.....	.....	.....	.....	12.5	3.8	0	1.5	4.5
		Durum:									
75	1440	Kubanka	.....	.....	.....	.....	22.5	10.7	0	0	8.3

COTTONWOOD.

		Bluestem:									
169	2874	Haynes (Minn. No. 169)	.....	.....	.....	.....	2.1	1.8	0	4.0	2.0
		Bearded fife:									
67	3081	Red Fife	.....	.....	.....	.....	3.8	2.3	0	7.0	3.3
		Durum:									
75	1440	Kubanka	.....	.....	.....	.....	4.0	1.3	0	1.4	1.7

[1] Yield estimated.

The highest average yield for the eight years (1905 to 1912) at Brookings, as shown in Table III, was produced by the Arnautka durum wheat, 20.8 bushels to the acre. This variety exceeded all others in average yield by at least 25 per cent. The Kubanka durum (C. I. No. 1440) averaged 16.2 bushels; the Red Fife, a bearded common wheat, 16.1 bushels; and the Kubanka durum (C. I. No. 1541) 16 bushels to the acre. The average yield of four varieties of durum wheat was 17.1 bushels and of six varieties of common wheat 13.9 bushels.

The data from the Highmore substation show that there have been two total failures during the 8-year period (1905 to 1912). Although some grain was obtained each season, there was not a sufficient

quantity to pay for harvesting in 1911 and 1912, and for that reason the small yields obtained are not reported. Notwithstanding these two seasons of total failure, the production of wheat has been profitable for the period as a whole. The highest average yield, as at Brookings, was produced by a durum variety, the Kubanka (C. I. No. 1516) leading with 17.7 bushels to the acre. The highest yielding common wheat was the Red Fife, with 12.5 bushels, closely followed by the Haynes Bluestems, Minnesota Nos. 51 and 169. The average yield of six varieties of durum wheat for the 8 years was 16 bushels to the acre, while that of eight varieties of common wheat was 11.5 bushels.

For the stations at Eureka and Cottonwood the yields of three representative varieties for the four years from 1909 to 1912 are given. The highest average yield at Eureka was produced by the Kubanka durum, 8.3 bushels to the acre, while at Cottonwood the bearded common wheat, Red Fife, has yielded best, 3.3 bushels.

During the 4-year period 1909 to 1912 wheat has been produced at an average loss of about 43 per cent of the cost of production at Eureka and of about 77 per cent at Cottonwood. These results are similar to those generally obtained during this period in the portions of the State where these stations are located. At Highmore wheat has been produced at an average loss of 38 per cent during this same period, but for the 8-year period 1905 to 1912 an average profit of 29 per cent has been obtained from the production of wheat of the varieties reported in Table III. This bears out the conclusion that the farmer in the semiarid portion of South Dakota can produce wheat profitably in a long period of years, but that for short periods he is likely to lose. In practice this would mean that wheat growing in that area should be considered as but one part of the business of the farm rather than its main dependence.

In figure 2 the yields of some of the leading varieties of wheat are shown graphically. It will be noted that the same varieties that have done well at Brookings have also given good results at Highmore, but that the relative position of the two strains of Kubanka, C. I. No. 1440 (S. Dak. No. 75) and C. I. No. 1516 (S. Dak. No. 73), is reversed, and that the Red Fife, C. I. No. 3081 (S. Dak. No. 67), is a much closer competitor of the Kubanka at Brookings than at Highmore. In each case the averages are in favor of the early-maturing bearded varieties.

In this diagram the average yields obtained are represented by solid horizontal lines. These are cut at the 10-bushel mark by a vertical line, the 10-bushel yield to the left of this line being estimated as equal to the average cost of production. That portion of the yield line extending to the right of the vertical line represents

the number of bushels produced in excess of the average cost and thus represents the profit obtained.

In determining which variety to grow in any given locality it is necessary to consider the milling quality, the time required from seeding to maturity, and the yield. These points will be discussed in subsequent paragraphs with regard to each of the leading varieties.

The data in Table IV are arranged to present a comparison of the producing capacities of the two principal climatic areas of the State. This table shows that the average yields of the groups of improved varieties discussed in this bulletin, with one exception, have been greater than the average for the entire State from miscellaneous

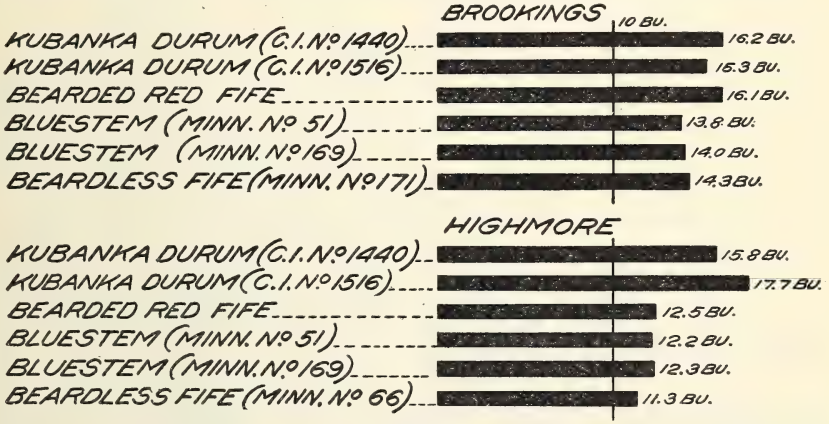


FIG. 2.—Diagram showing the average production in bushels to the acre of the leading varieties of each type of wheat grown at Brookings and Highmore, S. Dak., for the eight years from 1905 to 1912, inclusive. The vertical line indicates the yield necessary to cover the estimated cost of production.

varieties or mixtures. The one exception is the beardless fife group at Highmore. Considering that there have been two total failures at Highmore, this superior showing is a striking indication of the value of using good seed of productive varieties.

TABLE IV.—*Average acre yields of wheat in bushels in South Dakota and of the different groups of varieties at Brookings and at Highmore for the eight years from 1905 to 1912, inclusive.*

Locality.	Class.	Average yield per acre (bushels).								
		1905	1906	1907	1908	1909	1910	1911	1912	Average.
Entire State	All	13.7	13.4	11.2	12.8	14.6	12.8	4.0	14.2	12.1
Brookings	Bluestem	16.0	21.8	8.8	11.8	16.0	14.7	3.3	19.3	13.9
	Fife	14.6	21.8	7.3	11.2	15.5	15.7	1.8	17.4	13.2
	Bearded fife	18.3	22.3	10.9	15.0	21.8	19.9	2.8	18.5	16.1
	Durum	19.6	31.3	13.5	18.6	15.5	9.8	2.9	26.0	17.1
Highmore	Bluestem	23.5	16.4	16.8	15.2	16.3	8.9	0	0	12.1
	Fife	15.3	18.3	13.6	10.6	17.0	8.8	0	0	10.5
	Bearded fife	25.5	20.3	18.7	11.0	17.5	6.8	0	0	12.5
	Durum	29.9	26.4	25.4	24.8	14.4	7.1	0	0	16.0

The average yield of the bluestem wheats at Brookings is 1.8 bushels to the acre higher than the yield of this group at Highmore, as shown in Table IV. The average yield of the beardless fifes is 2.7 bushels, that of bearded fife 3.6 bushels, and that of the durums 1.1 bushels higher at Brookings than at Highmore. Plant diseases, particularly rust, have lowered the yields at Brookings, while drought has been the cause of low average yields at Highmore. These results indicate that there is not as great a difference in the producing power of the two sections of the State as has been generally supposed. The quality of the wheat at Highmore has invariably been excellent, while that at Brookings has been affected at times by rust or wet weather in harvest.

CULTURAL METHODS.

In Table V the results of an experiment to determine the possible gain by the use of better seed and by alternating wheat with a cultivated crop are reported. The work was done at Highmore in 1910. The best seed which was possible to separate with an ordinary fanning mill was sown on land previously used for cultivated alfalfa in rows. For comparison, ordinarily well-cleaned seed similar to that used in all other field experiments was sown on fall-plowed land previously in wheat. The experiment was conducted with a representative variety of each group.

TABLE V.—*Results obtained at Highmore, S. Dak., in 1910, from sowing well-graded seed wheat on well-prepared land in comparison with ordinary seed sown on land prepared in the ordinary manner.*

Group.	Good methods.				Ordinary methods.				Differences.			
	Days to mature.	Weight per bushel.	Yield.		Days to mature.	Weight per bushel.	Yield.		Days to mature.	Weight per bushel.	Yield.	
			Grain.	Straw.			Grain.	Straw.			Grain.	Straw.
		Lbs.	*Bush.*	*Cwt.*		*Lbs.*	*Bush.*	*Cwt.*		*Lbs.*	*Bush.*	*Cwt.*
Bluestem	95	58.0	11.7	18.7	102	54.0	8.9	7.6	−7	4.0	2.8	11.1
Bearded fife	93	59.5	11.6	22.5	96	60.0	6.5	5.7	−3	− .5	5.1	16.8
Fife	94	57.0	15.0	17.2	100	54.5	11.3	7.8	−6	2.5	3.7	9.4
Durum	97	60.5	17.7	26.6	95	58.0	5.6	11.6	2	2.5	12.1	15.0
Average	95	58.8	14.0	21.3	98	56.6	8.1	8.2	−3	2.2	5.9	13.1

It will be seen from Table V that the yield of grain and of straw was increased in each case by the use of the better methods, while the weight per bushel was higher, with one exception. These results were so conclusive that the experiment was not repeated. It is now becoming common practice to grow as much as possible of the wheat crop on land previously used for an intertilled crop.

LEADING VARIETIES.

Among all the varieties tested a few of outstanding merit should be more widely known and more generally grown. By growing these varieties the farmers of South Dakota can increase the quantity and improve the quality of the wheat produced in the State. With a full knowledge of each of the leading varieties the individual farmer can decide which he prefers to grow. He can then endeavor to improve the quality of his crop and keep it above the average. Among the most promising varieties are the Red Fife, Haynes Bluestem, Scotch Fife, Kubanka, and Arnautka. The fifes and bluestems are common wheats, while the Kubanka and Arnautka are durums.

The results of a milling test of several of these varieties of wheat are shown in Table VI. Further reference to this table will be made in the discussion of the varieties, which follows. Cross sections of loaves of bread made from these varieties are shown in Plate I.

TABLE VI.—*Results of a milling test of seven varieties of wheat grown at the Highmore, S. Dak., substation in 1910.*

C. I. No.	Variety.	Flinty kernels.	Water content.	Protein (N×6.25).	Weight of 1,000 kernels.	Weight per bushel.	Condition.	Bran.	Coarse shorts.	Fine shorts.	Low-grade flour.	Flour.	Error.[1]
		Per cent.	*Per cent.*	*Per cent.*	*Gms.*	*Lbs.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3082	Marvel Bluestem.	100	8.63	18.56	21.40	60.5	Plump....	5.4	11.4	1.9	4.2	71.5	3.0
3081	Red Fife.....	0	8.69	18.37	24.10	63.0	.....do....	6.7	13.3	2.9	3.2	69.6	4.4
2492	Manchuria.....	0	8.39	21.00	18.70	62.5	.....do....	11.7	16.1	1.9	3.9	65.6	7.6
1440	Kubanka.....	100	8.60	17.81	30.20	63.0	.....do....	1.0	13.0	3.0	5.0	72.5	3.1
1354	Do.....	100	8.52	18.56	26.80	62.5	Shriveled .	3.3	9.4	4.9	6.8	72.2	5.1
1516	Do.....	98	8.40	17.69	27.30	63.4	Plump....	3.2	8.4	3.4	10.4	72.6	6.4
3080	Arnautka.....	100	8.96	19.12	26.20	61.0	.....do....	1.1	14.8	3.8	5.0	73.9	7.6

[1] In this table, the data marked "Error" represent the moisture absorbed by the wheat in tempering, which differs with the variety, as well as the actual error in grinding and weighing. All work was done by the same method and the results are strictly comparable.

THE FIFE GROUP.

The fife group of common wheat is beardless with smooth white glumes. These wheats are often known collectively as Scotch Fife. The kernels are dark red, with sutures of varying shapes. Among the principal varieties of this group are the Fife (Minn. No. 163), Power Fife (Minn. No. 66, S. Dak. No. 142, C. I. No. 2989, and S. Dak. No. 172, C. I. No. 3025), Rysting Fife (Minn. No. 171, S. Dak. No. 136, C. I. No. 3022), and Saskatchewan Fife. The Ghirka (S. Dak. No. 69, C. I. No. 1517) has longer and lighter colored kernels than the other varieties of the group, but is otherwise similar to them.

Power Fife.—The Power Fife (Minn. No. 66, S. Dak. No. 142, C. I. No. 2989) is a typical variety of the beardless-fife group. It is of good milling quality, and usually produces grain which is a little more plump than that of the bluestem varieties. It is difficult to distinguish a sample of grain of this group from bluestem wheat, though the kernels average a little shorter in proportion to their width, and some of them have narrow, incurving sutures.

At Brookings this Power Fife has yielded 1.2 bushels less annually than the Haynes Bluestem (Minn. No. 169) in the 8-year test, while at Highmore it has yielded 1 bushel less during the same period (Table II). Since the distribution of this variety by the Minnesota station, a selection known as Minnesota No. 163 has been produced. This latter selection has not been included in the South Dakota trials during the 8-year period under discussion, but it has been grown at Highmore for five years and appears to be at least as good as Minnesota No. 66. The average yields of the two stocks for that period have been practically the same, 8.6 bushels per acre for Minnesota No. 66 and 8.4 bushels for Minnesota No. 163. These varieties mature a few days earlier than the varieties of the bluestem group and for that reason are not so badly affected by rust.

THE BEARDED-FIFE GROUP.

The varieties of the bearded-fife group of common wheat are bearded and have smooth white glumes (chaff). The kernels are dark red in color, with narrow incurving sutures. They are known commercially in the hard spring-wheat district as "Velvet Chaff," though the chaff is smooth and this name is therefore wrongly applied. The typical variety of the group is the Red Fife (S. Dak. No. 67, C. I. No. 3081). It also includes the South Dakota Climax, Golden Fife, Early Java, and Preston (Minn. No. 188). A number of typical heads of the Red Fife are shown in figure 3.

Red Fife.—The Red Fife variety (S. Dak. No. 67, C. I. No. 3081) requires about 95 days from seeding to maturity, as compared with 105 days for the bluestem wheats. Its earliness makes it less susceptible than the varieties of that group to damage from rust or from midsummer drought. It has withstood drought at Highmore better than any other variety except one or two recent importations from west-central Asia which do not appear to be good milling wheats. The origin of this variety is not definitely known; the stock used by the South Dakota station in these investigations was obtained from G. H. Carroll, of Miller, S. Dak., who obtained it from Iowa. It is probable that if the original source could be located it would be some region with a climate similar to that of this State, possibly the "black-earth" region of south-central Russia.

The Red Fife has given the highest average yield of any of the varieties of common wheat at all the stations, with an 8-year average acre yield of 16.1 bushels at Brookings and 12.5 bushels at Highmore. It is a little inferior to the Marvel Bluestem in milling value, containing 1.3 per cent more bran, 2.9 per cent more shorts, 1 per cent less low-grade flour and 1.9 per cent less straight flour (Table VI). This lower milling value affects the market price, so that this and the related varieties usually sell for about 3 cents per bushel less than bluestem wheat. However, it has recently been officially admitted to

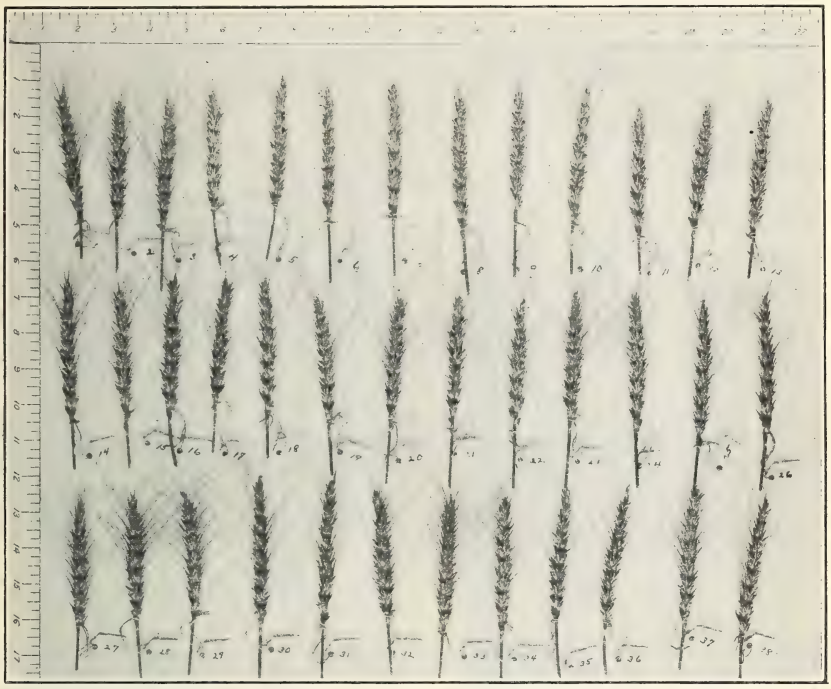


FIG. 3.—Selected heads of the Red Fife wheat (C. I. No. 3081) used in the wheat-breeding nursery at Highmore, S. Dak.

grade with "northern" (hard spring) wheat on the Minneapolis and Chicago markets and this difference in price will doubtless disappear.

THE BLUESTEM GROUP.

The varieties of the bluestem group of common wheat are beardless, with white, hairy chaff. The kernels are dark red, with wide, outcurving sutures. Among the varieties of this group are the Haynes Bluestem (Minn. Nos. 51 and 169), Pedigreed Bluestem (S. Dak. No. 140), Okanogan Bluestem (S. Dak. No. 145), Marvel Bluestem (S. Dak. No. 195, C. I. No. 3082), and Select Bluestem

(S. Dak. No. 196, C. I. No. 3083). Figure 4 shows a number of typical heads of bluestem wheat; these are selections from the Haynes Bluestem (Minn. No. 51) made at the Highmore substation in 1910. The milling qualities of the bluestem wheats are so well recognized by the trade that it is taken as the standard by which other varieties are rated in milling value.

Haynes Bluestem.—The strain of the Haynes Bluestem wheat known as Minnesota No. 169 (S. Dak. No. 169, C. I. No. 2874) was

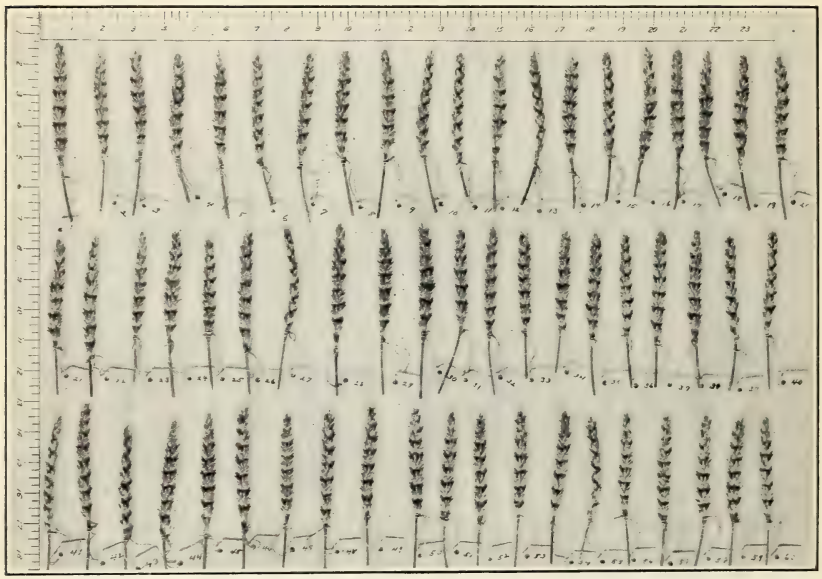
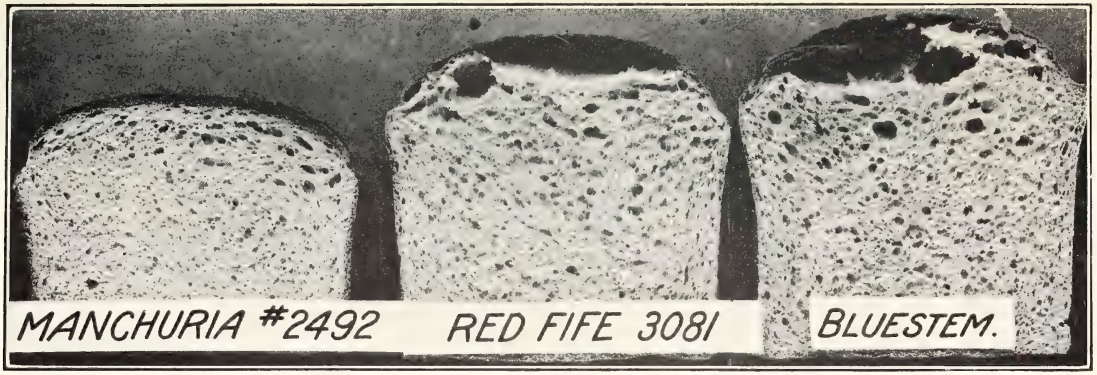
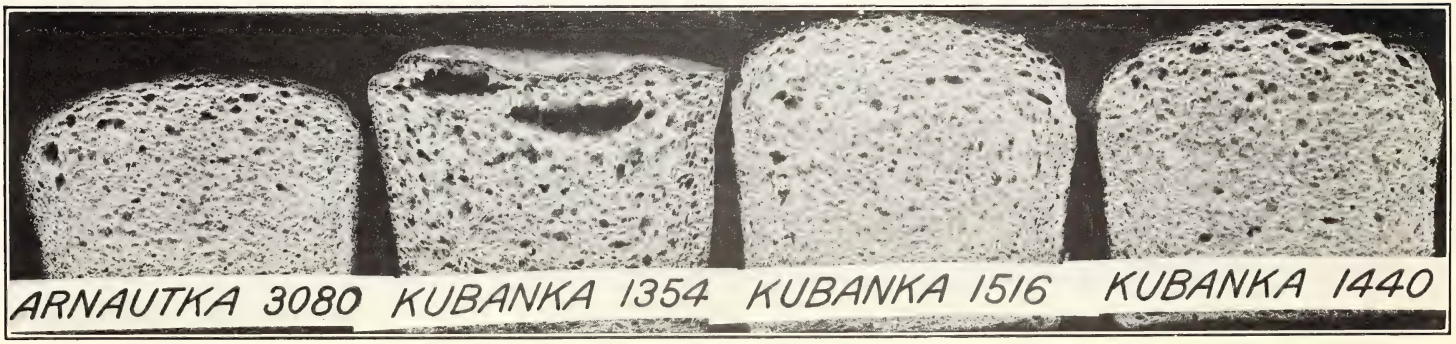


FIG. 4.—Selected heads of the Haynes Bluestem wheat (Minn. No. 51) used in the wheat-breeding nursery at Highmore, S. Dak.

originated by the Minnesota Agricultural Experiment Station. It is a selection from the Haynes Bluestem (Minn. No. 51) obtained from a grower in Manitoba. Because of its uniformity and superior quality it is a good example of the possibilities of improving wheat by selection. This variety appears to be the best of the bluestem wheats, as usually it has slightly exceeded other varieties of this group in yield. It can not be distinguished by its appearance from other bluestem wheats, but it is very uniform in size and shape of grain and in height of plant.

The Haynes Bluestem should be classed as a late wheat, as it requires about 105 days to mature in normal seasons, the time being slightly longer in a cool, wet season and shorter in a hot, dry one. Owing to its lateness it is seriously affected by rust and midsummer drought, though it often escapes early drought for the same reason. This fact is important, for many growers have rejected early varie-





CROSS SECTIONS OF LOAVES OF BREAD MADE FROM EQUAL QUANTITIES OF FLOUR FROM SEVERAL VARIETIES OF WHEAT GROWN AT HIGHMORE, S. DAK., IN 1910.

ties because they did not yield well in a season of early drought. The next season they planted late varieties, only to find that in that year the drought came later and was equally injurious to the late varieties. As is shown by the yields reported in Table II, the Haynes Bluestem (Minn. No. 169) has yielded less than the Red Fife (S. Dak. No. 67) at Highmore in four seasons and more in two, the average being 0.2 bushel in favor of the Red Fife.

THE DURUM GROUP.[1]

The durum wheats have smooth yellowish white glumes, with long awns. The principal varieties are the Kubanka and the Arnautka, the former with large, dark-amber kernels, the latter with large kernels of a clear amber and longer in proportion to their thickness than those of Kubanka. The heads of Kubanka are also shorter than those of Arnautka. The Kubanka durum wheats include South Dakota Nos. 73, 75, 152, and 356 (C. I. Nos. 1516, 1440, 1541, and 1354, respectively), while South Dakota Nos. 148, 149, and 151 (C. I. Nos. 1494, 1493, and 1547, respectively), and South Dakota No. 150 are of the Arnautka variety.

Kubanka.—The Kubanka (S. Dak. No. 75, C. I. No. 1440) is considered the best durum wheat for South Dakota. It is one of the best yielding varieties in our tests, averaging 0.1 bushel more per acre than the Red Fife at Brookings and 3.3 bushels more at Highmore. It also compares favorably with the bluestem wheats in milling quality, producing 1 per cent more flour, 4.4 per cent less bran, 2.7 per cent more shorts, and 0.8 per cent more low-grade flour, as shown in Table VI. The loaf made from this flour is of better quality than that made from the bluestem wheats, as will be seen by examining the photographs of the cross sections of the loaves shown in Plate I. It does, however, have a yellowish tinge, which is usually considered objectionable by those accustomed to a snow-white flour. Milling quality is a very important consideration in determining the value of a variety of wheat. During some seasons durum wheat has been quoted at as much as 15 per cent below bluestem wheat in price. This difference has gradually disappeared, and from September, 1912, to September, 1913, the price per bushel for durum wheat was higher than the price of bluestem wheat.

There is great variation in milling quality among durum-wheat varieties, as reported by Shepard.[2] Of all the varieties tested Kubanka (C. I. No. 1440) was the best in milling quality. The trials

[1] For a more complete discussion of durum wheat see Salmon, Cecil, and Clark, J. A. Durum wheat. U. S. Department of Agriculture, Farmers' Bulletin 534, 16 p., 4 figs., 1913.

[2] Shepard, J. H. Macaroni wheat: Its milling and chemical characteristics and its adaptation for making bread and macaroni. South Dakota Agricultural Experiment Station, Bulletin 92, 39 p., 4 pls., 1905.

reported in Table V agree with those reported by Prof. Shepard in this particular. It seems probable that if all the durum wheat grown in South Dakota was of this variety the market would demand the product each year at a price equal to that paid for bluestem wheat. Since the yield of the Kubanka (C. I. No. 1440) is 15.7 per cent greater at Brookings and 20.3 per cent greater at Highmore than that of the Haynes Bluestem (Minn. No. 169) it may readily be seen how much that would mean to the State of South Dakota.

This variety owes its yielding power mainly to its ability to resist rust and to respond quickly to favorable climatic conditions. In un-

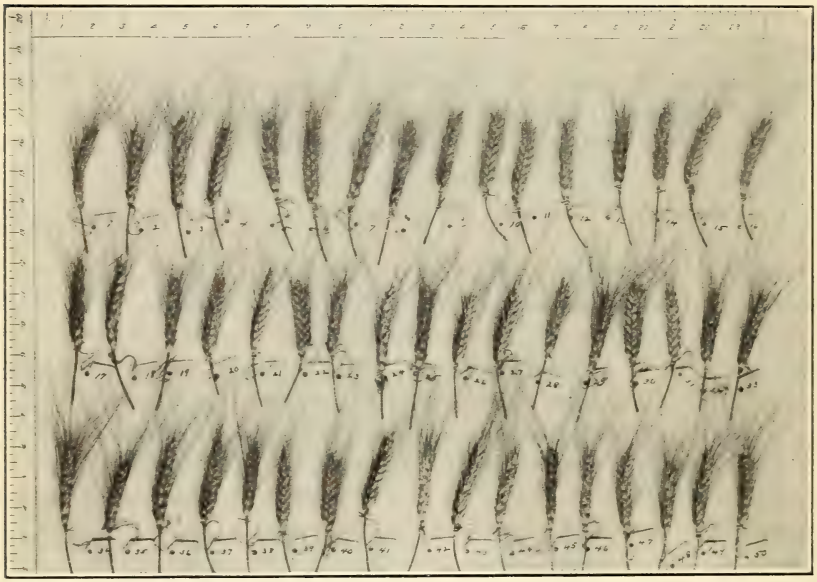


FIG. 5.—Selected heads of the Kubanka durum wheat (C. I. No. 1440) used in the wheat-breeding nursery at Highmore, S. Dak.

favorable seasons it suffers more severely from drought than the Red Fife (S. Dak. No. 67, C. I. No. 3081). It matures in about 100 days, and if sown at the same time ripens a few days earlier than bluestem wheat. It holds its seed well, being superior in that respect to any of the varieties of common wheat. This is a decided advantage when the acreage on any one farm is large, as some of it is likely to become overripe before the harvest is completed. Care should be taken to make sure that it is ripe enough to cut before beginning to harvest, because the glumes, or chaff, turn yellow before the grain is ripe.

The Kubanka durum wheat was obtained in Russia by Mr. M. A. Carleton when he visited that country as an agricultural explorer for the United States Department of Agriculture in 1899. He made several importations of this and other varieties of durum wheat. Among

them all the stock known as C. I. No. 1440 (S. Dak. No. 75) has proved the best for South Dakota conditions. This variety, typical heads of which are shown in figure 5, should receive more attention from the growers of South Dakota.

Arnautka.—The variety of durum wheat known as South Dakota No. 150 is typical of the Arnautka group. It is the only one of this group that has excelled the Kubanka (C. I. No. 1440, S. Dak. No. 75) in yield. At Brookings it has exceeded the latter by an average of 4.6 bushels and at Highmore by 0.4 bushel per acre, as shown in Table II. A comparison of these yields indicates that it is peculiarly adapted to the locality of Brookings, but that at Highmore, where the conditions in normal seasons are more nearly typical of the State as a whole, it is not materially better in yield than the Kubanka (C. I. No. 1440). This variety matures a day or two later than Kubanka.

In milling quality the Arnautka is inferior to the Kubanka. According to a test made by Shepard [1] from samples grown at the Highmore substation, the Kubanka (C. I. No. 1440) made 15.5 per cent more flour than the Arnautka (S. Dak. No. 150). This stock of the Arnautka was obtained from Fargo, N. Dak., in 1904. Further than that, its history is unknown. Everything considered, it seems advisable to discourage rather than to encourage the growing of this variety, and for this reason the experiment station has not distributed it.

EXPERIMENTS WITH OATS.

PRODUCTION IN SOUTH DAKOTA.

The production of oats in South Dakota has doubled during the last 10 years, a condition which is due to the increase in acreage rather than to an increased yield per acre. The climatic conditions of South Dakota are not especially favorable to the production of this crop, but at least enough should be grown each year to supply the home demand. If more attention were given to growing pure varieties and keeping the product up to a better standard, a better price would doubtless result directly from the increased demand.

The investigations here reported were for the purpose of determining what varieties among those now existing are best adapted to this State. Briefly, they show that certain varieties are much better adapted to South Dakota conditions than others and that considerable improvement in yield and quality of the crop can be obtained by the more common use of these varieties.

The average production of oats in South Dakota for the 10 years from 1903 to 1912 was 33,673,100 bushels, with an average yield of 29.3 bushels per acre. If the price is such that the first 20 bushels per acre will pay the cost of production, the raising of oats has

[1] Shepard, J. H. Macaroni or durum wheats. (A continuation of Bulletin 92.) South Dakota Agricultural Experiment Station, Bulletin 99, pp. 105–115. 1906.

given the State an average profit of 46 per cent during the decade. On this basis there has been one season, 1911, when oats were produced at an average loss of 63 per cent and two other seasons, 1908 and 1910, when there was very little gain. The data are presented in detail in Table VII:

TABLE VII.—*Annual and average acreage, acre yield, and total production of oats in South Dakota for the 10 years from 1903 to 1912,*[1] *inclusive.*

Year.	Area.	Yield per acre.	Production.	Year.	Area.	Yield per acre.	Production.
	Acres.	*Bushels.*	*Bushels.*		*Acres.*	*Bushels.*	*Bushels.*
1903	706,000	38.6	27,267,000	1909	1,559,000	27.9	43,566,000
1904	713,000	39.0	27,825,000	1910	1,550,000	23.0	35,650,000
1905	721,000	39.0	28,104,000	1911	1,540,000	7.4	11,396,000
1906	1,275,000	36.4	46,410,000	1912	1,550,000	33.8	52,390,000
1907	1,325,000	24.7	32,728,000				
1908	1,365,000	23.0	31,395,000	Average	1,230,400	29.3	33,673,100

[1] Data supplied by the Bureau of Statistics, U. S. Dept. of Agriculture.

For the 5-year period from 1907 to 1911 the climatic conditions were much less favorable than during the four years immediately preceding. In 1912 the season was again favorable to the production of oats. Climatic conditions have been the main factor causing variation in yield. It is thus apparent how important it is to have

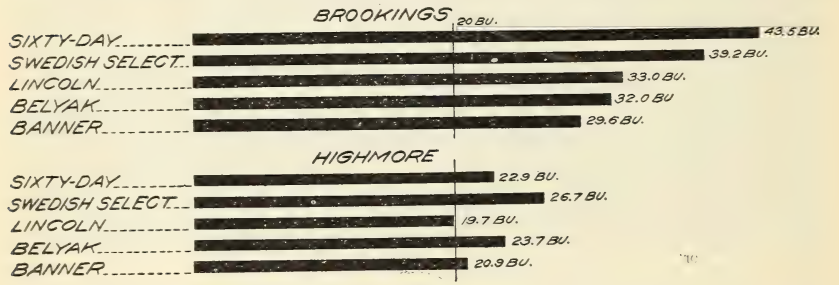


FIG. 6.—Diagram showing the average production in bushels to the acre of the leading varieties of oats grown at Brookings and Highmore, S. Dak., for the seven years from 1906 to 1912, inclusive. The vertical line indicates the yield estimated as necessary to cover the cost of production.

adapted varieties of oats. These best respond to favorable conditions or best resist unfavorable ones, so that, on the average, for a period of years, they are able to produce the best yields of grain of good quality.

VARIETAL TESTS.

The results of trials of a number of varieties of oats at the various stations in South Dakota are presented in Table VIII. The Banner variety (S. Dak. No. 116, C. I. No. 160), which is included in these tests, is typical of the oats quite generally grown in the State. With this variety for comparison the reader can form an accurate idea of the value of the better varieties and of the result if more attention were given to the growing of the best ones. In this table the annual

and average acre yields for each variety and the average yield for all varieties each year are given. A portion of the data for Brookings and Highmore is also shown graphically in figure 6. The performance of varieties at Brookings is representative of what might be expected in the eastern part of the State.

TABLE VIII.—*Annual and average yields in South Dakota of the varieties of oats tested at Brookings and Highmore from 1906 to 1912 and of two varieties at Eureka and Cottonwood from 1909 to 1912.*

BROOKINGS.

S. Dak. No.	C. I. No.	Group and variety.	Yield per acre (bushels).							
			1906	1907	1908	1909	1910	1911	1912	Average.
		EARLY WHITE.								
165	165	Sixty-Day	61.6	24.7	59.2	46.7	28.7	19.4	64.0	43.5
		EARLY BLACK.								
174	174	North Finnish Black	.....	45.4	20.6	28.6	28.4	10.9	73.1	[1] 34.5
		MEDIUM LATE WHITE.								
112	134	Swedish Select	61.6	24.1	25.0	44.0	29.0	4.7	86.0	39.2
161	151	Lincoln	42.2	14.1	17.6	33.0	29.4	8.0	86.5	33.0
336	336	Belyak	42.8	9.1	26.8	28.9	27.8	2.0	86.5	32.0
116	160	Banner	42.7	8.1	2.5	22.2	30.0	3.6	98.1	29.6
	162	American Triumph	45.5	10.9	4.3	31.4	26.5	1.6	.....	[1] 20.0
	163	American Beauty	43.8	10.3	5.0	25.9	28.4	2.2	.....	[1] 19.3
		LATE WHITE SIDE.								
	154	Wideawake	35.0	11.9	12.5	29.7	25.3	.9	.....	[1] 19.2
	445	White Tartar	32.3	6.3	10.4	25.8	26.6	1.9	.....	[1] 17.2
		Average	45.3	16.5	18.4	31.6	28.0	5.5	82.4	[2] 28.8

HIGHMORE.

		EARLY WHITE.								
165	165	Sixty-Day	43.3	31.6	47.5	28.8	9.4	0	[3] 0	22.9
115	539	Kherson	69.7	28.8	39.0	21.9	10.0	0	[3] 0	24.2
		EARLY BLACK.								
174	174	North Finnish Black	58.8	25.0	26.3	30.6	19.4	0	[3] 0	22.9
		MEDIUM LATE WHITE.								
112	134	Swedish Select	65.0	30.3	30.3	36.6	25.0	0	[3] 0	26.7
		Regenerated Swedish Select	.....	.....	27.0	20.0	11.6	0	[3] 0	[4] 11.7
336	336	Belyak	55.6	26.6	21.3	22.8	36.9	0	[3] 0	23.7
116	160	Banner	62.5	31.6	.....	16.8	14.7	0	[3] 0	[5] 20.9
161	151	Lincoln	45.6	30.6	29.7	15.6	16.3	0	[3] 0	19.7
	158	Holstein Prolific	48.8	26.3	22.5	17.8	16.6	0	[3] 0	18.9
		LATE BROWN.								
286	286	Red Algerian	49.6	21.9	32.8	23.4	35.0	0	[3] 0	23.2
		LATE WHITE SIDE.								
	445	White Tartar	44.7	26.3	25.0	4.7	.....	0	[3] 0	[5] 16.8
	154	Wideawake	42.5	24.7	28.9	10.6	.....	0	[3] 0	[5] 17.8
		Average	53.3	27.6	30.0	20.8	19.5	0	0	[6] 20.8

[1] Average for six years only. The crop failure of 1911 caused the loss of seed and made it impossible to continue some of the tests. This, however, does not affect the relative position of the varieties.
[2] Average of varietal averages. Average of annual averages is 32.5 bushels.
[3] While small yields were obtained in 1912, they were not sufficient to pay for harvesting and are therefore not considered. No variety was sufficiently resistant to withstand the severe conditions and yield profitably.
[4] Five-year average.
[5] Six-year average.
[6] Average of varietal averages. The average of annual averages is 21.6 bushels.

TABLE VIII.—*Annual and average yields in South Dakota of the varieties of oats tested at Brookings, etc.*—Continued.

EUREKA.

S. Dak. No.	C. I. No.	Group and variety.	Yield per acre (bushels).							
			1906	1907	1908	1909	1910	1911	1912	Average.
		EARLY.								
165	165	Sixty-Day	.....	.....	.....	37.2	20.2	0	6.1	15.9
		MEDIUM LATE.								
112	134	Swedish Select	.....	.....	.....	43.7	25.0	0	4.7	18.4
		Average	.....	.....	.....	40.5	22.6	0	5.4	17.1

COTTONWOOD.

		EARLY.								
165	165	Sixty-Day	.....	.....	.....	12.5	4.4	0	25.9	10.7
		MEDIUM LATE.								
112	134	Swedish Select	.....	.....	.....	7.2	6.3	0	16.6	7.5
		Average	.....	.....	.....	9.9	5.4	0	21.3	9.1

Of the varieties grown at Brookings for the seven years from 1906 to 1912 the best average acre yields were produced by the Sixty-Day, 43.5 bushels, and the Swedish Select, 39.2 bushels. These yields were considerably higher than those of any other variety in the test, exceeding those of the Banner, which, as already noted, is quite typical of the oats generally grown in the State, by 13.9 and 9.6 bushels, respectively.

Similar data are shown in Table VIII for the trials at Highmore, which are representative of the central portion of the State. At that point it will be noted that there were two total failures, though in the area as a whole there was only one—that of 1911. Of the varieties here recorded five yielded less than 20 bushels per acre, and were therefore produced at a loss. The average for all varieties reported for all years shows a profit of 4 per cent of the cost of production, while on the best variety there was a profit of 33 per cent of the cost of production. It is evident, therefore, that the profit or loss in growing oats under conditions similar to those at Highmore during the seven years from 1906 to 1912 would have depended upon the variety used.

The highest average yields at Highmore were produced by the Swedish Select and Kherson varieties. The Swedish Select averaged 26.7 bushels to the acre for the 7-year period from 1906 to 1912; the Kherson, 24.2 bushels; and the Sixty-Day, 22.9 bushels. The Sixty-Day was slightly exceeded in yield by the Belyak and the Red Algerian.

At Cottonwood and Eureka oat growing has not been profitable during the last four years, even when the best varieties were used, as shown in Table VIII. That it has been profitable at Highmore during the last seven years again illustrates the fact that one must make plans on a long-time basis in order to succeed in a region of limited moisture. It is also evident that no attempt should be made to grow oats in central and western South Dakota for market purposes, but the surplus in favorable seasons should be kept to provide feed for live stock in the less favorable years. By this method oats may be utilized profitably in that area, but if freight is paid to ship the crop out in good seasons and to bring it back in bad seasons profit can scarcely be expected.

In Table IX the yields of two of the best varieties at Brookings and at Highmore for the 10 years from 1903 to 1912, inclusive, are compared with the average production of oats for the State for the same period. These data show that the Swedish Select variety (S. Dak. No. 112, C. I. No. 134) at Brookings exceeded the average for the State by 9.5 bushels, and at Highmore by 4.2 bushels for the 10 years. During these years the Sixty-Day oat at Brookings exceeded the average yield of oats for the State by 17.6 bushels per acre, and at Highmore lacked but 0.3 bushel of equaling the State average, notwithstanding the three unfavorable seasons at that station (1910 to 1912).

TABLE IX.—*Annual and average yields of Swedish Select and Sixty-Day oats at Brookings and at Highmore, S. Dak., from 1903 to 1912, with the average yield of all varieties for the entire State for comparison.*

Locality.	Variety.	Yield per acre (bushels).										
		1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	Average.
Entire State....	All.....	38.6	39.0	39.0	36.4	24.7	23.0	27.9	23.0	7.4	33.8	29.3
Brookings.....	Swedish Select..	[1] 0	70.0	43.5	61.6	24.1	25.0	44.0	29.0	4.7	86.0	38.8
Highmore.....	.....do.....	38.1	54.4	55.0	65.0	30.3	30.3	36.6	25.0	[2] 0	[2] 0	33.5
Brookings.....	Sixty-Day.....	[1] 0	84.5	80.0	61.6	24.7	59.2	46.7	28.7	19.4	64.0	46.9
Highmore.....	.....do.....	24.1	41.2	64.0	43.3	31.6	47.5	28.8	9.4	[2] 0	[2] 0	29.0

[1] Crop destroyed by hail. [2] Crop destroyed by drought.

CULTURAL METHODS.

In Table X the results of an experiment to determine the gain which may be expected by better farming methods are reported. In this experiment oats are grown in rotation with an intertilled crop, using seed of the best grade obtainable by means of an ordinary fanning mill. This is compared with ordinary, well-cleaned seed sown on land well plowed and prepared, but which had produced a crop of oats the previous year. The test was made at Highmore

in 1910, a very dry season, so that the differences are probably greater than they would have been in a season of abundant moisture. Several representative varieties were used in the experiment. The evidence was so conclusive that the yield could be increased by this method that it was not considered necessary to repeat the trial.

TABLE X.—*Results obtained in 1910 at the Highmore, S. Dak., substation from well-cleaned seed of four varieties of oats when grown after an intertilled crop, in comparison with ordinary well-cleaned seed when grown after oats.*

Variety.	Good cultural methods.				Ordinary cultural methods.				Differences.			
	Days to mature.	Weight per bushel.	Yield of grain.	Yield of straw.	Days to mature.	Weight per bushel.	Yield of grain.	Yield of straw.	Days to mature.	Weight per bushel.	Yield of grain.	Yield of straw.
		Lbs.	*Bu.*	*Cwt.*		*Lbs.*	*Bu.*	*Cwt.*		*Lbs.*	*Bu.*	*Cwt.*
Sixty-Day	88	32	21.9	25.0	86	25.0	9.4	5.7	2	7	12.5	19.3
Kherson	89	36	21.9	17.0	84	30.0	10.0	6.8	5	6	11.9	10.2
Swedish Select	95	39	35.9	29.5	100	27.0	25.0	10.2	−5	12	10.9	19.3
Regenerated Swedish Select	94	35	18.8	14.0	94	30.0	11.6	6.8	0	5	7.2	7.2
Average	91.5	35.5	24.6	21.4	91	28.0	14.0	7.4	.5	7.5	10.6	14.0

As shown by the data presented in Table X, the good methods increased the yield of grain and straw and gave a product of better quality, as is shown by the increased bushel weight in each case. These data are in accord with those obtained by other experiment stations and with the experience of many farmers. It is therefore advisable to grow oats in alternation with a cultivated crop in the central part of the State and to use thoroughly fanned seed. Just how much of the gain was due to each factor was not determined.

COMPOSITION OF VARIETIES.

Table XI presents some data on the composition of the different varieties of oats included in the test. The figures, which are for the 1910 crop at the Highmore substation, include the percentages of hull, protein, and water, and the weight of 1,000 grains for each of 10 varieties. A pure-line selection of the Sixty-Day (C. I. No. 626) and ordinary Sixty-Day (C. I. No. 165) were highest in percentage of protein and lowest in percentage of hull. The Swedish Select also shows a low percentage of hull and high protein content, while in size of the grain, as shown by the weight per 1,000 kernels, it greatly exceeds the Sixty-Day. As the low percentage of hull and high protein content both indicate a high feeding value, it is evident that these two varieties are desirable for this reason as well as for their high yield.

TABLE XI.—*The weight of 1,000 grains and the percentage of hull, water, and protein of 10 varieties of oats grown at the Highmore, S. Dak., substation in 1910.*

S. Dak. No.	C. I. No.	Variety.	Weight of 1,000 grains.	Hull in whole grain.	Water content.	Protein.
			Grams.	*Per cent.*	*Per cent.*	*Per cent.*
157	626	Sixty-Day selection	21.2	22.2	8.63	18.56
165	165	Sixty-Day	17.2	24.0	7.82	17.50
115	539	Kherson	19.1	24.9	7.79	15.75
112	134	Swedish Select	27.3	25.5	7.43	17.00
174	174	North Finnish Black	17.8	25.7	7.76	16.50
.....	.....	Ligowo (Minn. No. 6)	27.3	27.0	7.13	16.69
26	.....	Early Gothland (Minn. No. 26)	22.3	27.1	7.27	17.12
.....	.....	Regenerated Swedish Select	28.8	27.8	7.44	15.75
286	286	Red Algerian	28.8	28.3	7.48	14.63
336	336	Belyak	24.1	28.9	7.18	15.87
		Average	23.4	26.1	7.59	16.54

LEADING VARIETIES FOR SOUTH DAKOTA.

The varieties of oats commonly grown in South Dakota have been obtained from the States to the eastward and from Canada. According to the results of these trials, they are not as well adapted to local conditions as certain other varieties imported from regions having climatic conditions more nearly like those prevailing in South Dakota. Recently considerable progress has been made in bringing better adapted varieties into common use, but even yet there is far too large a proportion of the crop grown from seed of unadapted varieties.

Other things being equal, the best variety to grow of a given crop is the one which has made the best average performance record. With definite information about each the farmer can make up his mind which is preferable for his conditions. The varieties of oats which have succeeded best in the tests here reported are the Sixty-Day, Kherson, and Swedish Select.

Sixty-Day.[1]—The Sixty-Day oat (C. I. No. 165, S. Dak. No. 165) may be distinguished from other varieties by its small, slender, yellowish white grain. It ripens early and thus escapes climatic conditions that seriously injure later varieties. Mainly for this reason it exceeds all varieties in yield at Brookings, where it produced 47 per cent more grain than the Banner and 11 per cent more than the Swedish Select during the period from 1906 to 1912, as reported in Table VIII. At Highmore, where the late varieties have not been injured by hail, the Sixty-Day has not yielded as well as the later Swedish Select, but it has outyielded the Banner by 9.5 per cent. At Cottonwood the conditions have been a little more favorable to the Sixty-Day than to the later varieties. At Eureka the climatic condi-

[1] For a full discussion of the Sixty-Day and Kherson varieties of oats, see Warburton, C. W., Sixty-Day and Kherson oats, U. S. Department of Agriculture, Farmers' Bulletin 395, 27 p., 5 fig., 1910.

tions are similar to those at Highmore, and here again the Swedish Select has outyielded the Sixty-Day. As shown by Table XI, the Sixty-Day variety of the Highmore crop of 1910 contained 17.5 per cent of protein and 24 per cent of hull. The weight of 1,000 grains was 17.2 grams. Heads of this variety are shown in figure 7.

The Sixty-Day oat was introduced from Proskurov, Russia, by the United States Department of Agriculture in 1901. Since that time it has been widely distributed and is now obtainable in commercial quantities. It can be recommended as the best early variety for the South Dakota grower.

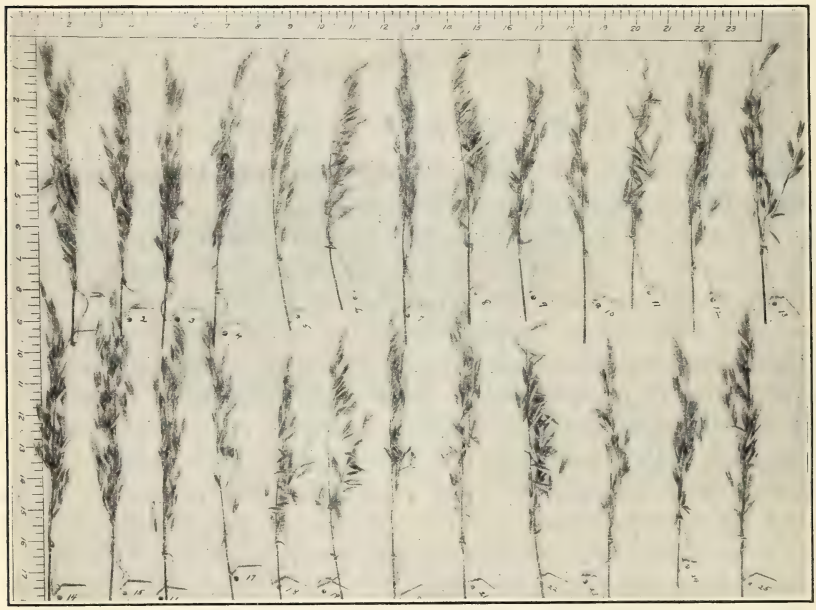


FIG. 7.—Selected heads of the Sixty-Day oat (C. I. No. 165) used in the oat-breeding nursery at Highmore, S. Dak.

Kherson.—The Kherson (C. I. No. 539, S. Dak. No. 115) is identical in appearance with the Sixty-Day and nearly the same in performance. The grain is a little larger and more starchy, containing less protein in proportion to the total weight. It also contains a slightly higher percentage of hull. These statements are based upon the data reported in Table XI. The samples used in this study were grown at Highmore in 1910. It may be that these differences would not hold if the average results were available. To all external appearances the varieties are identical.

Swedish Select.—The Swedish Select (C. I. No. 134, S. Dak. No. 112) is a medium-late white oat which was introduced from St. Petersburg, Russia, by the United States Department of Agriculture

in 1899.[1] Since that time it has been widely distributed over the Northern States. It has outyielded all other varieties at Highmore and all medium-late varieties at Brookings in the 10-year period from 1903 to 1912. This variety should not be confused with the Regenerated Swedish Select, which, though bearing a similar name, has been bred in England for humid conditions. Under the severe conditions prevailing at Highmore this English strain or variety did not equal the original Swedish Select in yield during the seasons of 1908, 1909, and 1910. The average yield for the five years during which this regenerated variety has been on trial was 11.7 bushels, as compared with 18.4 bushels for the original Swedish Select for the

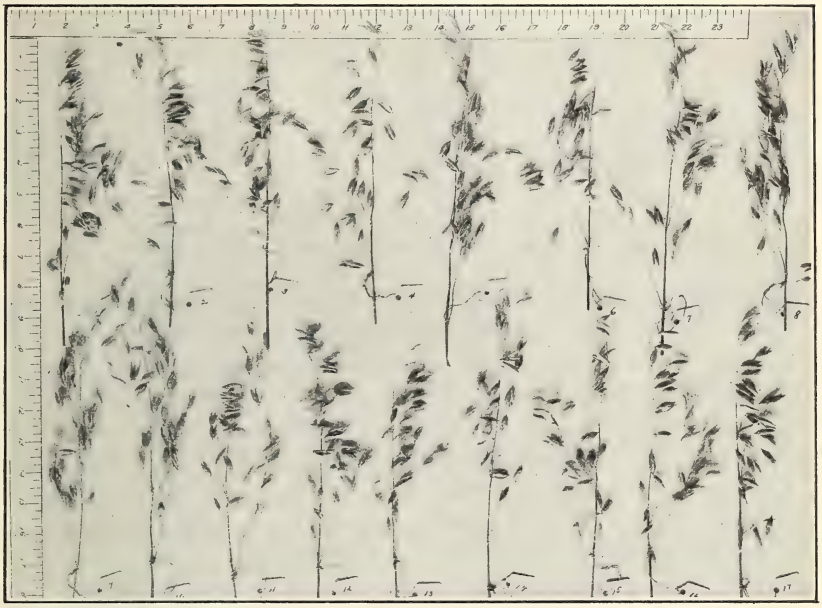


FIG. 8.—Selected heads of the Swedish Select oat (C. I. No. 134) used in the oat-breeding nursery at Highmore, S. Dak.

same period. Under less severe conditions the Regenerated Swedish Select has given good results.

As reported in Table XI, the Swedish Select as grown at Highmore in 1910 has 25.5 per cent of hull, 17 per cent of protein, and weighs 27.3 grams per 1,000 grains. These figures show that it is not quite equal to Sixty-Day in feeding value and the grains are more than 1.6 times as heavy. Selected heads of the Swedish Select oat are shown in figure 8. Everything considered, the Swedish Select can be recommended as the best producing medium-late variety and more attention can well be given to growing it.

[1] Carleton, M. A. Ten years' experience with the Swedish Select oat. U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 182, 47 p., 4 fig., 4 pl., 1910.

EXPERIMENTS WITH BARLEY.

PRODUCTION IN SOUTH DAKOTA.

The production of barley in South Dakota has more than doubled in the 10 years from 1903 to 1912. As with oats, this increased production has resulted wholly from the increase in acreage, for the yield per acre has remained practically the same. Table XII shows the annual and average acreage, acre yield, and total production of barley in South Dakota for the 10 years from 1903 to 1912, inclusive.

TABLE XII.—*Annual and average acreage, acre yield, and production of barley in South Dakota for the 10 years from 1903 to 1912, inclusive.*[1]

Year.	Area.	Yield per acre.	Production.	Year.	Area.	Yield per acre.	Production.
	Acres.	*Bushels.*	*Bushels.*		*Acres.*	*Bushels.*	*Bushels.*
1903	339,000	31.4	10,656,000	1909	1,115,000	20.1	22,396,000
1904	350,000	28.0	9,788,000	1910	1,050,000	18.2	19,110,000
1905	332,000	30.0	9,962,000	1911	1,020,000	5.4	5,508,000
1906	790,000	29.0	22,910,000	1912	887,000	26.0	23,062,000
1907	875,000	23.0	20,125,000				
1908	928,000	26.5	24,592,000	Average	768,600	23.8	16,810,900

[1] Data supplied by the Bureau of Statistics, U. S. Department of Agriculture.

Table XII shows that the average annual area devoted to barley in South Dakota was 768,600 acres during the 10-year period, with an average annual production of 16,810,900 bushels. The area increased from 339,000 acres in 1903 to 1,115,000 acres in 1909; since that time it has decreased somewhat, 887,000 acres being devoted to the crop in 1912. The average acre yield has ranged from 5.4 bushels in 1911 to 31.4 bushels in 1903; the average yield for the 10 years was 23.8 bushels. If 16 bushels per acre will pay the cost of production, the net profit on the barley crop during the 10 years has averaged 48 per cent of this cost, and the season of 1911 is the only one during the last decade in which the crop has not been profitable to the State as a whole. While the cost of production varies from season to season and in different localities, this estimate indicates that barley has been produced at a greater profit than either wheat or oats.

VARIETAL TESTS.

Barley growing is a comparatively new industry in this State, and relatively little attention has been given to the improvement of the crop. The main essentials for the growing of better barley are a better knowledge of varieties and greater care in preventing mixtures. The object of the experiments here reported was to find what improvement might be made by introducing better varieties in place of the mixed barley commonly grown. It was first necessary to make comparative tests to determine which varieties should

be distributed. The results of these varietal trials at Brookings and at Highmore for the eight years from 1905 to 1912 and at Cottonwood and Eureka for the four years from 1909 to 1912 are presented in Table XIII.

TABLE XIII.—*Annual and average acre yields of barley in South Dakota in varietal tests at Brookings and Highmore for the eight years from 1905 to 1912 and at Eureka and Cottonwood for the four years from 1909 to 1912, inclusive.*

BROOKINGS.

S. Dak. No.	C. I. No.	Group and variety.	Yield per acre (bushels).									
			1905	1906	1907	1908	1909	1910	1911	1912	Average.	Number of years tested.
		SIX-ROWED.										
102	638	Manchuria (Minn. No. 6)	49.0	41.0	34.6	28.8	24.6	24.2	0	[1]39.3	30.2	8
105	576	Manchuria (Minn. No. 105)	.....	.....	.....	.....	.....	.....	.....	58.3	.....	1
182	182	Odessa	45.2	50.5	32.1	30.6	26.3	27.7	.4	57.2	33.8	8
		TWO-ROWED.										
189	189	Kitzing	54.7	53.8	22.9	49.1	15.2	24.8	.2	50.0	33.8	8
107	35	Chevalier	64.2	50.3	22.5	32.7	15.4	11.0	.8	32.0	28.6	8
	200	.....do	54.6	49.0	20.0	23.2	17.9	10.8	2.5	[2]	[3]25.4	7
21	530	.....do	60.0	48.8	20.8	26.5	19.4	12.7	2.1	[2]	[3]27.2	7
	343	Moravian	50.1	54.3	24.4	18.1	18.7	10.6	.8	[2]	[3]25.3	7
	171	Surprise	35.2	41.4	16.5	22.2	16.5	11.5	.3	[2]	[3]20.5	7
24	24	Hanna	60.6	46.4	19.2	30.1	14.6	19.2	0	25.2	26.9	8
20	531	Hannchen	57.7	49.4	22.7	18.0	11.5	14.4	1.0	39.1	26.7	8
		Average	53.1	48.5	23.6	27.9	18.0	16.7	.8	43.0	[4]27.8	.....

HIGHMORE.

		SIX-ROWED.										
102	638	Manchuria (Minn. No. 6)	37.0	42.3	22.7	24.4	14.6	8.1	0	0.1	18.7	8
105	576	Manchuria (Minn. No. 105)	.....	.....	22.7	27.7	15.8	14.6	0	.1	13.5	6
178	.....	Oderbrucker	.....	.....	.....	28.3	15.6	10.8	0	.4	11.0	5
182	182	Odessa	.....	.....	23.8	32.4	15.8	7.5	0	2.0	13.6	6
123	261	Mariout	.....	.....	.....	.....	.....	15.6	0	4.2	6.6	3
126	626	Common California	.....	.....	.....	.....	.....	8.3	0	4.0	4.1	3
124	190	Beldi	.....	.....	.....	.....	.....	12.5	0	6.9	6.5	3
122	575	Gatami	.....	.....	.....	.....	.....	8.0	0	8.6	5.5	3
262	262	Hull-less	.....	.....	.....	.....	.....	3.3	0	.3	1.2	3
		TWO-ROWED.										
24	24	Hanna	50.6	36.8	22.9	34.6	15.6	13.3	0	.3	21.8	8
27	27	Bohemian	46.8	31.3	27.7	38.4	20.8	19.2	0	.2	23.0	8
28	195	White Smyrna	45.4	30.4	19.6	27.9	19.6	14.0	0	8.6	20.7	8
364	529	Princess	40.8	47.9	22.7	18.8	11.0	10.8	0	.2	19.0	8
21	530	Chevalier	48.5	50.6	25.2	22.9	14.8	15.4	0	.2	22.2	8
20	531	Hannchen	41.8	56.8	26.0	29.0	15.8	14.6	0	.2	23.0	8
	31	Horn	54.4	25.4	21.5	28.1	15.4	.....	.....	.....	29.0	5
	47	Striegum	47.9	25.4	18.6	32.1	14.2	.....	.....	.....	27.6	5
	48	Golden Melon	51.0	28.5	20.8	26.4	11.5	.....	.....	.....	27.6	5
	532	Primus	40.0	36.4	27.3	22.0	9.8	.....	.....	.....	27.1	5
		Average	45.8	37.4	23.2	28.1	15.0	11.8	0	2.4	[5]16.9	.....

[1] Average of three plats not in the varietal series.
[2] Because of the drought of 1911 the seed of several varieties was lost and it was necessary to discontinue growing them.
[3] Average for seven years only (1905 to 1911).
[4] Average of varietal averages. The average of annual averages is 29.0 bushels.
[5] Average of varietal averages. The average of annual averages is 20.5 bushels.

TABLE XIII.—*Annual and average acre yields of barley in South Dakota in varietal tests at Brookings and Highmore, etc.*—Continued.

EUREKA.

S. Dak. No.	C. I. No.	Group and variety.	Yield per acre (bushels).									
			1905	1906	1907	1908	1909	1910	1911	1912	Average.	Number of years tested.
105	576	Manchuria (Minn. No. 105)					32.6	6.0	0	2.1	10.2	4
122	575	Gatami								23.4		1
20	531	Hannchen					31.5	3.8	0	19.5	13.7	4
28	195	White Smyrna					19.0	7.2	0	7.8	8.5	4
		Average					27.7	5.7	0	13.2	[1] 10.8	

COTTONWOOD.

S. Dak. No.	C. I. No.	Group and variety.	Yield per acre (bushels).									
			1905	1906	1907	1908	1909	1910	1911	1912	Average.	Number of years tested.
105	576	Manchuria (Minn. No. 105)					2.0	3.1	0	[2] 0	1.3	4
20	531	Hannchen					6.1	3.5	0	[2] 0	2.4	4
		Average					4.0	3.3	0	0	1.8	

[1] Average of varietal averages. The average of annual averages is 11.7 bushels.
[2] Destroyed by cutworms.

The results reported in Table XIII show that the highest average yields in the 8-year test at Brookings, 33.8 bushels to the acre, were produced by the Odessa (6-rowed) and the Kitzing (2-rowed) varieties. The Manchuria, another 6-rowed variety, has yielded better than any 2-rowed variety except the Kitzing. In general, it appears that the 6-rowed barleys are to be preferred in eastern South Dakota. The reverse is true at Highmore, as the six 2-rowed varieties which have been grown for eight years (1905 to 1912) have averaged 21.6 bushels to the acre, while the Manchuria (Minn. No. 6), a 6-rowed variety, has averaged only 18.7 bushels. The highest average yield for this period, 23 bushels to the acre, was produced by the Bohemian and Hannchen varieties. Figure 9 shows graphically the average yields of the leading varieties at Brookings and Highmore. The Hannchen has given the best results at Eureka in the four years from 1909 to 1912. At Cottonwood only two varieties, the Hannchen and Manchuria, have been grown. Neither of these varieties has produced a profitable crop at this station in any of the four years the test has been conducted.

If it is again assumed that the production of 16 bushels to the acre will pay the cost of production, all the varieties of barley at Brookings were grown at an average profit of 81 per cent on this cost, while the Odessa variety (S. Dak. No. 182, C. I. No. 182) returned an average profit of 111 per cent. At Highmore the average profit on all varieties for eight years has been only 5 per cent

on the cost of production, but the Hannchen (S. Dak. No. 20, C. I. No. 531) and the Bohemian (S. Dak. No. 27, C. I. No. 27) have returned a profit of 44 per cent. The profit obtained from these selected varieties shows the value of pure strains of superior merit. At Eureka the best yielding variety, the Hannchen, has been grown at an average loss of 15 per cent for the four years from 1909 to 1912, and the three varieties tested have been produced at an average loss of about 33 per cent. The two varieties grown at Cottonwood returned only about 10 per cent of the cost of production during the four years of the test. For the entire State the average production was 22.3 bushels for the eight years (Table XIV), or 6.3 bushels more than the equivalent of the estimated cost of production (16 bushels). This is a profit of about 40 per cent.

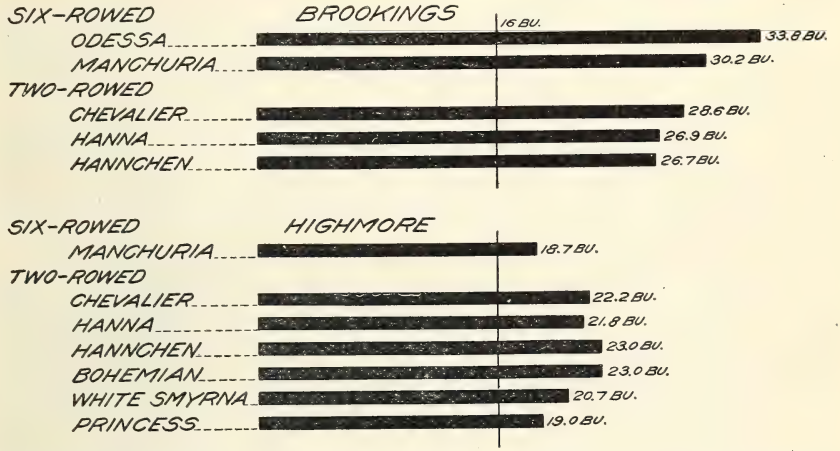


FIG. 9.—Diagram showing the average production in bushels to the acre of the leading varieties of 6-rowed and 2-rowed barley grown at Brookings and Highmore, S. Dak., for the eight years from 1905 to 1912, inclusive. The vertical line indicates the yield estimated as necessary to cover the cost of production.

TABLE XIV.—*Annual and average yields per acre in bushels of all barleys in South Dakota and of the leading varieties at Brookings and Highmore for the eight years from 1905 to 1912, inclusive.*

Locality.	Variety.	Yield per acre (bushels).								
		1905	1906	1907	1908	1909	1910	1911	1912	Average.
Entire State	All varieties	30.0	29.0	23.0	26.5	20.1	18.2	5.4	26.0	22.3
Brookings	Manchuria (Minn. No.6)	49.0	41.0	34.6	28.8	24.6	24.2	0	39.3	30.2
	Odessa	45.2	50.5	32.1	30.6	26.3	27.7	.4	57.2	33.8
	Hannchen	57.7	49.4	22.7	18.0	11.5	14.4	1.0	39.1	26.7
Highmore	Manchuria (Minn. No.6)	37.0	42.3	22.7	24.4	14.6	8.1	0	.1	18.7
	Odessa	.....	.....	23.8	32.4	15.8	7.5	0	2.0	.....
	Hannchen	41.8	56.8	26.0	29.0	15.8	14.6	0	.2	23.0

From a commercial standpoint the growing of pure varieties is of even greater importance in the production of barley than of oats or

wheat. As uniform germination is essential for brewing and as varieties differ in the length of time required for germination, the best results are obtained from pedigreed selections. The danger of mixing in thrashing and other operations is great where varieties of different groups are grown in the same locality; hence, it is desirable to confine the production of barley in a community to a single group or, better still, to a single variety. As the varieties of the different groups of barley do not succeed equally well in the different parts of South Dakota it is suggested that the State, so far as the production of barley is concerned, be divided into eastern, central, and western districts as follows:

(1) Eastern district: That part of the State east of the James River. In this district 6-rowed varieties, such as Manchuria and Odessa, should be grown.

(2) Central district: That part of the State between the James and Missouri Rivers. The 2-rowed varieties, Hannchen, Bohemian, and Kitzing, should be grown here.

(3) Western district: That part of the State west of the Missouri River. As the crop can be fed to stock in this district to better advantage than it can be marketed, little attention need be given to market requirements, but only the most drought-resistant varieties should be grown. These may be either 2-rowed or 6-rowed.

The policy of developing separate producing areas has been adhered to during 1912 by the South Dakota station and the United States Department of Agriculture in the distribution of seed, and if the growers will realize the importance of this movement much good will be accomplished. By this means South Dakota barleys will be made pure and uniform in each district. The barley market will doubtless respond to this improvement and the South Dakota grower will reap the reward.

So much work is in progress in various parts of the world in the breeding and improvement of barley that it is difficult to keep pace with the output of new varieties. For example, the Wisconsin Agricultural Experiment Station has recently distributed pedigreed strains of Manchuria barley. Without a test extending through several years it is impossible to say whether or not these Wisconsin selections are as well adapted to conditions in South Dakota as the varieties already tested. As soon as new varieties are obtained from the breeders they are placed in the tests at the station, and if any are found to be superior to the ones now recommended the information is readily available. It is not at all certain that a variety which has done well in Canada or Wisconsin will succeed in South Dakota. Experimenting on a large scale is expensive and hazardous, and such tests are best conducted by the State experiment station at public expense. It is a safe policy for the South Dakota farmer to depend on

the results obtained at the station rather than to test new varieties or strains at his own expense.

COMPOSITION OF VARIETIES.

The weight per bushel, the weight of 1,000 grains, and the water and protein content of seven 6-rowed and seven 2-rowed varieties of barley grown at Highmore in 1910 are given in Table XV. This table shows that the seven varieties of 2-rowed barley averaged 3.6 pounds to the bushel heavier than the seven varieties of 6-rowed barley and that the protein content was 1.5 per cent higher. On the other hand, the 6-rowed varieties averaged 1.9 grams heavier per 1,000 grains. There was practically no difference in the water content. There was a wide variation in the weight of 1,000 grains of the 6-rowed varieties.

TABLE XV.—*Weight per bushel and of 1,000 grains and the water and protein contents of 14 varieties of barley grown at Highmore, S. Dak., in 1910.*[1]

S.Dak. No.	C. I. No.	Variety.	Weight per bushel.	Weight of 1,000 grains.	Water content.	Protein.
		SIX-ROWED.				
			Pounds.	*Grams.*	*Per cent.*	*Per cent.*
105	576	Manchuria (Minn. No. 105)	46.0	25.1	8.46	16.7
178	.....	Oderbrucker	43.0	24.1	8.65	17.4
124	190	Beldi	40.0	34.5	8.87	17.4
182	182	Odessa	43.0	25.8	8.63	17.3
123	261	Mariout	45.0	43.2	8.98	14.9
122	575	Gatami	50.0	30.2	8.77	18.8
127	617	Manchuria	42.0	23.6	8.44	16.7
		Average of seven 6-rowed varieties	44.1	29.5	8.68	17.0
		TWO-ROWED.				
24	24	Hanna	48.0	27.1	7.82	19.7
20	531	Hannchen	49.0	25.5	9.33	18.7
189	189	Kitzing	48.0	28.5	8.63	19.6
364	529	Princess	47.0	27.3	8.79	18.8
107	35	Chevalier	45.0	27.2	8.79	17.7
106	187	Svanhals	49.0	29.5	8.57	16.7
27	27	Bohemian	47.0	28.3	8.53	18.2
		Average of seven 2-rowed varieties	47.7	27.8	8.64	18.5

[1] Analyses made in Plant Chemistry Laboratory, Bureau of Chemistry.

LEADING VARIETIES.

As already stated, the 6-rowed varieties appear to be most productive in the eastern portion of the State, while in central South Dakota the 2-rowed varieties are to be preferred. From the tests conducted at the Brookings and Highmore stations, the best 6-rowed varieties are the Manchuria and Odessa, with the Hannchen and Kitzing ranking highest among the 2-rowed barleys.

SIX-ROWED VARIETIES.

Manchuria.—The Manchuria (Minn. No. 105) was obtained from the Minnesota station, by which it was secured from the Ontario

Agricultural College at Guelph, Ontario. It has been widely distributed by the Minnesota station. The Manchuria and Oderbrucker barleys have the six rows of grains arranged about the rachis to form a head which is square in appearance; hence the group to which they belong is often called "square head" or "four-rowed." Minnesota No. 105 has yielded better at Highmore than Minnesota No. 6, which is another stock of the Manchuria variety. Minnesota No. 105 was not grown at Brookings until 1912, when it yielded 58.3 bushels to the acre. As shown by Table XV, Minnesota No. 105 contained 16.7 per cent of protein, weighed 25.1 grams per 1,000 grains, and exceeded Oderbrucker in weight per bushel by 3

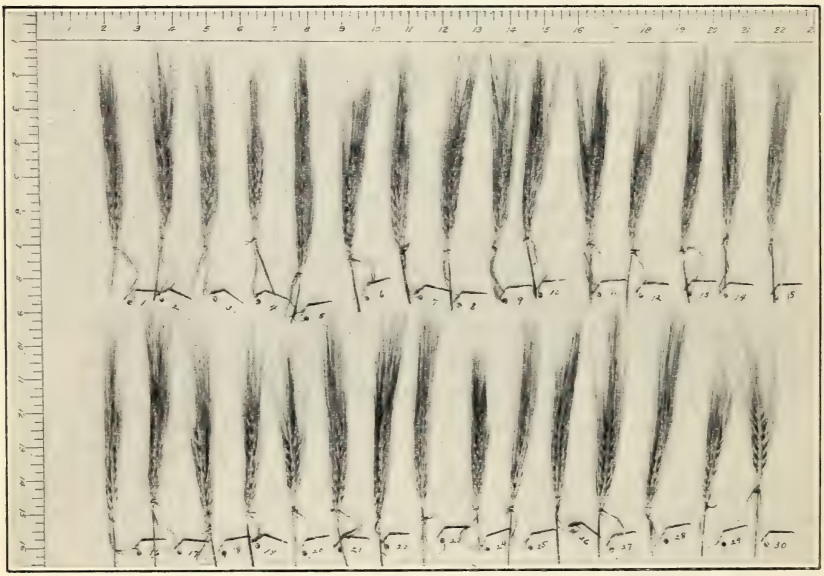


FIG. 10.—Selected heads of the Odessa barley (C. I. No. 182), the best early variety for eastern South Dakota.

pounds in the Highmore crop of 1910. It seems to be more vigorous and resistant under severe conditions than Oderbrucker, though the latter variety is probably as good in favorable seasons. Everything considered, it seems certain that more attention to this variety in the eastern district of South Dakota would improve the barley crop.

Odessa.—The Odessa (S. Dak. No. 182, C. I. No. 182) differs from the Manchuria in that it matures about a week earlier. There is little difference in the appearance of the plants or the heads. A number of selected heads of Odessa barley are shown in figure 10. It has yielded well in the trials at Brookings, excelling all other varieties on trial, except Kitzing, during the last eight years. In 1912 the Odessa yielded 1.1 bushels less than the Manchuria (Minn.

No. 105). At Highmore it has yielded practically the same as Minnesota No. 105 for six years. In protein content, weight of grain, etc., it appears to be about the same as Minnesota No. 105, as shown by Table XV.

It was introduced from the same region in Russia from which the Sixty-Day oat was obtained. Like that variety, Odessa barley owes its superiority to its earliness, which enables it to avoid severe conditions occurring late in the season. For those growers in the eastern district of South Dakota who desire an extra-early variety of barley the Odessa can be recommended.

FIG. 11.—Selected heads of the Hannchen barley (C. I. No. 531), the best variety for central South Dakota.

TWO-ROWED VARIETIES.

Hannchen.—The Hannchen (S. Dak. No. 20, C. I. No. 531) is a pedigreed 2-rowed barley, originated by selection from Hanna at the Swedish Seed-Breeding Institute at Svalof, Sweden. It was introduced into the United States by the Department of Agriculture. The long, slender heads nod at maturity. The beards have a tendency to drop off as the crop ripens, so that the crop is somewhat less objectionable to handle than the 6-rowed varieties. A number of selected heads of this variety are shown in figure 11.

Hannchen barley has been on trial at Brookings and Highmore for several years. As shown in Table XIII, it has been the highest yielding variety at Highmore and Eureka. At Highmore it has

averaged 4.3 bushels to the acre more than Manchuria (Minn. No. 6) in an 8-year test, and 0.8 bushel more than Manchuria (Minn. No. 105) in a 6-year test. At Highmore another variety of the Hanna group, the Bohemian (C. I. No. 27), has equaled the Hannchen in yield, but has been inferior in uniformity and quality. At Brookings the Hannchen has not yielded as well as the best 6-rowed varieties. Table XV shows that the 1910 crop of Hannchen barley at Highmore weighed 49 pounds to the measured bushel and that 1,000 grains weighed 25.5 grams. The protein content was 18.7 per cent.

Hannchen is a variety of 2-rowed barley to which the barley growers of central South Dakota can well afford to give more attention.

Kitzing.—The Kitzing barley (S. Dak. No. 189, C. I. No. 189) is very similar to the Hannchen in appearance. It is uniform and of good quality. At Brookings it has been the best yielding 2-rowed variety. It was first grown at Highmore in 1910, but has thus far shown no superiority to the Hannchen. The latter variety is probably to be preferred for the central district of the State. It is not advisable to grow the Kitzing barley in the eastern district, because of the danger of mixture with the 6-rowed varieties on the farm or at the elevator, thus lowering the value of both.

IMPROVEMENT OF THE GRAIN CROPS.

The improvement of the small-grain crops of South Dakota will be discussed in detail in a later publication, giving the results of the breeding work which is in progress at the Brookings and Highmore stations. A brief statement is included here to show what is necessary to make the crop-breeding work of the station and the United States Department of Agriculture of the fullest possible benefit to the grower. To obtain the best results, the grower must get seed of the best varieties and then keep this seed up to a high standard of purity and quality. Any variety of grain may deteriorate through the presence of inferior seed or through accidental mixture with other varieties if care is not taken to remove them from the seed each year.

One of the best plans for keeping seed pure is to use what is known as the seed-plat method. To put this method into effect it is necessary to select enough of the best-appearing heads from the field to furnish seed for a seed plat of perhaps 1 acre the following year. These heads should be dried thoroughly to avoid molding and then thrashed in the most convenient manner. The seed thus obtained should be thoroughly fanned and used to plant the seed-improvement plat. The crop from this plat will be available for seed for the main field for the ensuing year. Enough heads should be selected from the seed plat each year to sow the seed plat the following year. By thus growing a special seed plat each year the standard of excellence

of the variety may be maintained. The work involved is not great and could be carried out on a sufficient number of farms in the State to maintain a supply of home-grown seed of good quality.

Whether the seed plat is used or not, all seed grain should be thoroughly fanned to remove all light, inferior seed grain, weed seeds, and trash. If the seed is thus kept well graded, the so-called running out of the variety will be avoided.

SUMMARY.

The small-grain crops, wheat, barley, and oats, have been and still are one of the chief sources of wealth in South Dakota.

The production of wheat has not increased, while that of oats and barley has doubled during the decade from 1903 to 1912. There is usually sufficient moisture to produce these crops, though the frequent periods of high evaporation do considerable damage, particularly in the central and western portions of the State.

The soils of South Dakota east of the Missouri River are for the most part well suited to cereal production; those west of that river are extremely variable, though some are of value for grain growing.

In a climate like that of South Dakota it is very important to have adapted varieties. As a result of the investigations reported in this bulletin it is now possible to recommend such varieties of wheat, oats, and barley for the State. The following varieties are recommended:

(1) Wheat.
Kubanka durum (C. I. No. 1440), Haynes Bluestem (Minn. No. 169), Red Fife (C. I. No. 3081), and Fife (Minn. No. 163).

(2) Oats.
Swedish Select (C. I. No. 134) and Sixty-Day (C. I. No. 165).

(3) Barley.
(*a*) For the eastern district:
Manchuria (Minn. No. 105) and Odessa (C. I. No. 182).
(*b*) For the central district:
Hannchen (C. I. No. 531).
(*c*) For the western district:
Gatami (C. I. No. 575), Mariout (C. I. No. 261), and related varieties.

To obtain the fullest return from the use of these varieties, the seed must be kept pure and up to a high standard of quality.

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